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S. LYNN RHORER.

By JAMES J. MARSHALL.

S. Lynn Rhorer, the well-known amateur astronomer and founder of the Southern Cross Observatory at Miami, Florida, died April 21, 1929, at his home in Atlanta. Mr. Rhorer was celebrated for his devotion to the cause of popular astronomical education, in addition to being one of the outstanding amateur astronomers of the country.

He had been in failing health for several months and was unable to be present at the astronomical observatory during the season of 1929, after six years of outstanding attention to its work. The interest of Mr. Rhorer in astronomy was life-long and his part in the movement he characterised as "bringing the stars to the man in the street." This idea found fruit in 1923, when, after having visited the far southern city, he determined that the tropical skies visible there and the unusual climatic conditions made this an ideal spot for popular education. The plan, while apparently chimerical, proved eventually to be one of remarkable foresight. In a park in the down-town section in the center of the city, he obtained permission of the authorities to set up a single 5-inch Clark refractor and attended it personally for the enlightenment of any passer-by who desired to view the skies. The response was so enthusiastic that he at that time formed the plan of gathering about him the most interested of his observers and making them his assistants in his work. The addition of one telescope each year, until the number of seven had been attained, also formed part of the project and was carried into effect this past season. Mr. Rhorer found himself surrounded by amateur astronomers from all over the country who assisted in the work of explaining the objects viewed. The setting of the observatory was and has continued to be unique. The grass-grown plots surrounded by palm trees with the brilliant lights of lofty buildings, far enough away to allow good seeing, proved an attraction to the imagination of the visitors to Miami.

The observatory was opened at seven o'clock every evening and in theory closed at ten o'clock, but the time of closing was dependent entirely upon the interest shown by observers and in the case of the late rising of the moon, planets or interesting objects it has not been unusual for the observations to end with sunrise.

From time to time the work has been extended and during the past few years afternoon sessions given to viewing the sun were added. As the staff grew in proportion various other features were included. At an

early date lectures of short duration were made a part of the daily program and these were illustrated with stereopticon views from Yerkes, Mt. Wilson, and Harvard Observatories and slides from private collections. These pictures were thrown upon a screen erected in the park and the spectators viewed them from the seats on the grass or such accommodations as were available. In 1927 a weekly radio lecture was given by a member of the staff and transparencies were on view at all times. The observatory attained such a position in the city that it became a public institution and found it necessary to maintain a list of lectures for numerous engagements away from the site. A leading Miami paper published a daily column of some interesting celestial body, most of the articles for which were prepared by Mr. Rhorer. The attendance became phenomenal and it was not unusual to find each instrument the object of a line of spectators extending beyond the confines of the park. The attendance on one evening by actual count reached two thousand people. All these services by Mr. Rhorer and his assistants were rendered by Mr. Rhorer without cost of any sort.

Among those associated with him were Charles D. Higgs, of the Yerkes Observatory, John H. Chase of Youngstown, Ohio, Dr. David Fairchild, geologist, of Washington, Dr. Henry M. Ami, Vice-President of the Canadian Society, of Ottawa, George Babcock, author, of New York City, William Tyler Olcott of Norwich, Conn., Gar Wood of Detroit, Robert Henkel of Detroit, Clarendon Ions, F.R.A.S., Richard W. Gray, Edward Robertson, Dr. Jeremiah George, Gilman Low, and James J. Marshall of Miami.

Mr. Rhorer was himself an interested observer and was the first man in his longitude to observe Nova Aquilae in 1918. He was a faithful member of the American Association of Variable Star Observers and his name frequently appeared in POPULAR ASTRONOMY in the reports of this society. He was also a member of the Astronomical Society of the Pacific and president of the Amateur Society in his home city of Atlanta, Georgia. In recognition of his services to popular education he was in 1927 made a Fellow of the Royal Astronomical Society.

Mr. Rhorer enjoyed the friendship of many of the outstanding astronomers of the country and was able to obtain the services of several of these for large public lectures in connection with the Miami work. Dr. Harlow Shapley and Dr. E. B. Frost each made the trip to Miami to give two lectures, and Dr. Frederick Slocum appeared at the last large public lecture given before Mr. Rhorer's death. These lectures taxed the capacity of the largest auditorium in the city, and, like all other work of the observatory, were financed by Mr. Rhorer. In character Mr. Rhorer was modest to the point of self-effacement. To visitors to the observatory, perhaps more interested in the material aspects of the institution, he described himself as one of the group in charge of the work. He avoided publicity for himself although welcoming it for the movement and invariably refused to be seen in a prominent position

at the lectures which he sponsored, forbidding even the use of his name by the chairman and lecturer.

The members of the staff residing in Miami with the group of visiting members have determined to carry on the work as a monument to Mr. Rhorer and propose to extend it if possible.

Arrangements are now being made to place the institution on a solid foundation and to continue the welcome afforded to visitors.

DE DISCIPLINIS MATHEMATICIS.

(ON MATHEMATICAL STUDIES.)

Translation by Raymond H. Coon.

[Biographical Note—*During twenty years Uranieburg (the castle of the heavens) on the island of Huen near Copenhagen was the center of astronomical studies in Europe. The least known of that notable quartet of astronomers, of whom the other three were Copernicus, Kepler, and Galileo, was Tycho Brahe, who directed the researches at Uranieburg. No more picturesque personality is known in the history of science, nor a more intense devotion, a more untiring industry. His life covered almost precisely the latter half of the sixteenth century (1546-1601). A Danish nobleman, whom they first tried to make a soldier, then a lawyer, he had to fight for the notion that science* per se *was of value. However, the reformation had done something to liberate the human spirit, and Tycho was fortunate in receiving royal patronage, first from King Frederick II of Denmark and later from Rudolph II of Bohemia.*

Tycho is universally regarded as the founder of accurate instrumental astronomy. He impressed students of this science with the idea, not generally prevalent, that careful observations were indispensable, and himself contributed an elaborate series of painstaking astronomical observations continued over a period of many years. The instruments which he invented and those which he improved were an enormous advance over all that were employed before his day. He could calculate to within one-sixteenth of a degree, a rough calculation for modern instruments, but a striking improvement upon Ptolemy, whose observations were not nearer than half a degree. Between Ptolemy's time and his there had been no appreciable progress. Tycho's observations were used by Kepler, his associate and successor, as the basis for theoretical work as brilliant as the observational work of Tycho had been.

A new exhaustive and definitive edition of the entire body of Tycho's works (1913-1925) edited by J. L. E. Dreyer, published in Latin at Copenhagen in thirteen volumes, a very handsome piece of bookwork, is the only complete edition of our author. My purpose is to translate from the Latin—which was the language in general use by scholars of his day and which was a literary instrument in Tycho's hands—part of an address (published in Vol. I, pp. 145 ff.) which Tycho gave at the University of Copenhagen. The address was delivered in September, 1574, before the doctors, professors, and students of the University of Copenhagen. It was the first of a

series of public lectures which the king had asked him to give on the subject of astronomy. Copies of it have been exceedingly rare though it now becomes available in this expensive edition. The general theme is the value, the charm, the beauty of the sciences of mathematics and astronomy. While not possessing scientific value it has a genuine interest as it expresses the reflections of so distinguished a scientist. The latter part of the address, not included here, is devoted to astrology, in which Tycho, like most learned men of his day, seemed to have considerable confidence.—R. H .C.]

Distinguished men and students of the University, I have been asked by certain of you who are my friends and by his Highness the king himself to set forth in a public lecture some matters that concern the study of mathematics. Although this task is somewhat foreign to my situation and somewhat beyond my humble talent and training, it was not my privilege to refuse the request of his Royal Majesty, nor did I feel disposed to refuse yours. Furthermore of my own free will from early youth I have spent much time and energy in mastering this study and also, so far as I was able, have assisted the efforts of others, urging them to the same course. For it would be, I think, difficult for one to say, how much value these studies possess in comparison with all others, through the incredible fascination that attaches to unquestioned accuracy and to the most complete erudition. And not only in the strength of its demonstrations and in the beauty of its knowledge but in its variety and in the manifold abundance of its learning, does it far surpass all other studies; so that it deserved on this account to be called mathematics by the ancients, as alone being worthy the name *disciplinae* because of its surpassing qualities.[1] Now this whole field of study which goes under the name *mathesis* has to do in particular with the consideration of quantities, and is divided into two chief parts, that is geometry and arithmetic. Of these the latter deals with discrete quantities, the former with continuous. And from these two parents so to speak spring many other mathematical sciences that are learned and of which the knowledge is delightful. Most sublime and equally a source of delight is astronomy, the subject which makes a study of the motion and the harmony of the heavenly bodies. I shall speak of this later after having briefly discussed geometry and arithmetic upon which astronomy depends.

It is the prevalent belief that geometry originated among the Egyptians. The Nile flooded the adjoining fields effacing the boundary lines, and in consequence the science was developed whereby the ownership of the land after the flood had subsided might justly be determined anew. This science in all probability was called geometry because of the use which it first served, that is from the measuring of land. And

[1] The word "mathematics" is derived from the Greek word which means "learning," as the word "discipline" is derived from the Latin word which means "learning."

yet by no means does it serve such humble purposes as merely to measure lands and fields, but it explains all the magnitudes, forms, proportions which are intelligible to man, and, rising even to heaven, it reduces to certain knowledge those harmonies of heavenly movements which are real, that is intelligible to the senses. To this study at one time a great many masters of the sciences in Egypt and in Greece devoted their energies with enthusiasm. Certain individuals among them made contributions to the establishment of the science. One of them, Eucleides, the Megarian, issuing a volume on his discoveries, arranged the elements of the science in harmonious order and with great skill, so that they may be easily understood by any one possessing a modicum of insight. In this science Archimedes of Syracuse was so celebrated that he was thought to possess miraculous powers. By engines of war, built with the help of geometry, he long protected the walls of his native city from the repeated attacks of the Romans, and with extraordinary ingenuity set fire to the enemy's ships by means of mirrors which reflected fire from the sun. Although these actions do not highly commend geometry, since more important and more worthy objects can be accomplished with its help, the use of this divine science has contributed to the good of humanity and not to its destruction, and therefore should be highly esteemed by intelligent people. Moreover, words fail to describe the accuracy of this science, the charm, the practical advantage for all other studies and for every-day life. Ancient philosophers urged that mathematics be studied from early boyhood, either because, aside from its being most worth learning for its own sake, it distinguishes that which is true and logical in other studies, or because with its help the other forms of knowledge are acquired later with far less difficulty, since it trains and sharpens the intelligence. Moreover the judgment, not making hasty decisions, but being held in suspense for a time, after well-reasoned causes have been set forth, is improved. And so the divine Plato with good reason refused admission in his school to all who were not trained in geometry, and officially posted a statement to that effect, on the ground that such students were not qualified to understand the other departments of philosophy. I consider that ancient philosophers reached so lofty a pinnacle of learning because, from early boyhood, they were trained in geometry, while we unfortunately spend a great many years, and those the best years of youth, on grammar and language studies, which they learned without difficulty from their mothers' instruction. From geometry is derived that incomparably ingenious science of triangles, both plane and spherical[2] upon the foundation of which the entire knowledge of the stars is based. If this knowledge were completely lost, it could be restored anew provided the data were re-collected and made available. From geometry, optics are derived, the very obscure and at the same

[2] Trigonometry is the science to which he refers.

time very delightful study of the rays of vision. The elements of optics have been handed down in a ten volume work by Vitellio. The Arabian Alhazen was his successor in this subject. From geometry is derived the science of the sun dial, which traces on a surface the lines of shadows and of the sun dial clock, a study at once learned and useful. From geometry, geography, which treats of the positions of lands, of seas, of cities, had its beginning. (All these have their origin in geometry) to say nothing of architecture, aqueducts, engines of war, and the many mechanical contrivances discovered with the help of geometry, which manual tradesmen use, or which become instruments for observing the movements of the heavens and the stars and for making land measurements. Thus the study of geometry on the one hand deals with what is certain and with what yields pleasure, and on the other is inexhaustible in its variety. To put the whole matter briefly, no one can justly claim that he is master of any branch of learning who is unacquainted with geometry.

Among mathematical studies geometry is succeeded by arithmetic. Though this subject receives proofs of its first principles from geometry, yet it does not concern itself with continuous quantities but with discrete quantities, and devotes itself entirely to the consideration of numbers. How much practical utility this science, even applied in its trivial aspects, possesses in every-day life, I think all are aware, although the doctrine of numbers has a much wider application than, and involves a field of knowledge as boundless as, geometry, one that cannot be completely mastered by any man. Through arithmetic the Pythagoreans formerly veiled all the mysteries of nature and even of God, with the idea that everything harmonized with numbers as well as with shapes and proportions. And although this particular science won deathless renown for Pythagoras, yet there is no doubt that the Egyptians and peoples living near them were the first to arrive at an understanding of it, and that Pythagoras derived it from them. Josephus, the historian of Jewish antiquities, asserts that the Egyptians learned this from the patriarch Abraham. And so the science of numbers is as useful and learned as it is ancient.

From these two, geometry and arithmetic, another science has its origin, one that is sublime and far removed from contact with base earth. It is called astronomy. This study, unwilling to be bounded by the narrow limits of earth and sea and other elements, travels through the spacious heights of the ether, by the shining sun, and the white moon of many forms, among all the planets, as well as among the fixed stars. It reverently examines the movements of all these bodies, their harmonies, their revolvings, their proportions, and their sizes. From geometry it receives the help whereby it is enabled, by means of geometrical instruments constructed with unerring precision, to observe the phenomena of the stars, and to reduce them to hypotheses which correspond to the phenomena, by which the complicated variations of the

motions can be harmoniously explained. From arithmetic, astronomy receives this contribution: it takes the hypotheses discovered and set up by geometry, and, assigning them to their places, divides the entire ether into numbers, by which at any time one may determine in advance the courses of the stars. Now although astronomy is formed from these two sciences in the manner described into a definite form of knowledge, yet it surpasses not only these but all other forms of knowledge of this whole class, and, if I may say so, occupies the supreme place. Because of its antiquity and its noble and elevated content it claims the highest honor as compared with all others. For, to speak first of the very ancient beginnings of astronomy, what is there that antedates Adam and his sons? The aforementioned Josephus maintains that one of the sons, Seth, was the first to make a scientific study of the stars and that he handed it down to later generations. Josephus says that he (Seth) devoted his whole life time to observing and examining motions of the stars, and that finally he built two columns, upon which he carved his discoveries, that they might never be lost to human knowledge. And since that passage is noteworthy, let us hear Josephus himself as he reminds us of the very ancient origin of astronomy. He writes as follows in Book I:

> "Of the sons of Adam, Seth alone was educated. Arriving at the time of life at which he could distinguish between right and wrong, he gave himself wholly to the pursuit of virtue. And when he died a most noble man, he left offspring who followed in his path. Since they were all men of an excellent character, they dwelt in the land abstaining from sedition, passing their lives in unbroken happiness, and they observed the wise ordering and elegance of the heavenly bodies. Now that their discoveries might not be lost to the knowledge of men, since Adam had prophesied that destruction was to come to the world, once by fire and a second time by flood, they raised two columns, the one of brick, the other of stone, and engraved upon both an account of their discoveries, in order that, if it should be the fate of the brick to be destroyed by the flood, the column of stone surviving would make it possible for men to know, and would exhibit the inscription to all who saw the column."

These are the words of Josephus, who also adds the fact that one of the columns was still intact in Syria in his own day. It is credible that the science of the stars has come down from these first descendants of Adam to their successors and finally to the patriarchs. This fact the historian of Jewish antiquities does not hesitate to add:

> "The Patriarch Abraham first of all informed men who lived in his country that, as a result of the observations which he made on the sun, the moon, and the other heavenly bodies, there was one God, who was the founder and overseer of the universe, to whose will all nature yields; and that men ought to pay honor and express their gratitude to him alone."

Josephus, I say, asserts that Abraham learned these things from the everlasting and wonderful revolutions of the stars, and that he instructed others regarding them. Josephus also says that Abraham later went to Egypt and that he taught the Egyptians, among other things, not only the science of numbers, as I have said above, but also astronomy. For before the coming of Abraham they knew nothing of this science. Philo, also a writer on Jewish history, and one familiar with Plato's philosophy, gives a like account of Abraham, saying that, until he discovered God from his speculations on the heavenly bodies and until he became an astronomer, he was called Abram, but afterwards, when by special gift of God he was chosen to be a divine leader, he was called Abraham. And so it is clear that the study of the stars had its origin with our first parents at the beginning of the world, and from them by direct succession was delivered to the patriarchs. This is the more probable, as Josephus (already mentioned) clearly intimates, because it was their lot to live so long a life, a necessary condition for the careful observation of those intricate motions especially of the more slowly moving stars, not to mention the fixed stars, the study of which requires the longest life time. As far as records of astronomy have survived Timochares,[3] on the authority of Ptolemy, is considered the founder of the science, and secondly Hyparchus[4] of Rhodes is considered in a peculiar sense its founder. For the latter carefully observed the positions of the fixed stars, and marked the courses of the sun and the moon during many consecutive years, and was also undoubtedly most diligent in observing the planets and the entire heavens, though his writings on this subject have not survived to our time. Ptolemy, comparing the discoveries and reflections of Hyparchus with his own, reduced the entire science to a system of definite hypotheses, and also of definite calculations, and in consequence of that won undying fame for himself with all future generations.

> "As long as the sun shall illumine the vault of heaven, and as long as the wandering moon shall afford light by night, always shall his honor, name, and praise abide."[5]

After him Albategnius[6] endeavored to establish certain points more plainly, especially with regard to the fundamental movements of sun, moon, and fixed stars. On the basis of his work, king Alphonsus of

[3] He was a member of the Alexandrian school of astronomers and flourished in the first half of the third century B. C.

[4] Hipparchus (the usual spelling) was by far the greatest astronomer of the ancient world and one of the greatest in history. His work was done in the middle of the second century B. C. The results of his observations were used extensively by Ptolemy.

[5] Tycho frequently quotes from the Roman poets. His inaccuracy suggests that he often quotes from memory. The last verse of this quotation occurs twice in Vergil: *Ecologue* V 78; *Aeneid* I 609. I have failed to discover the source of the other two verses.

[6] An excellent astronomer and mathematician of the latter part of the ninth and the beginning of the tenth centuries. He was an Arab prince.

Arragon had a mass of tables made, which we still possess under his name, the task being performed by artisans whom he had attracted to his court at great expense. For the most part he drew on the work of Ptolemy, though he employed other authorities. In our own day indeed Nicolaus Copernicus, whom you might well call a second Ptolemy, perceiving from his own observations that there were certain points missing in Ptolemy, and thinking that the latter's hypotheses involved some inconsistency and were opposed to mathematical axioms, and discovering that the suppositions of Alphonsus were not in accord with the motions of the heavens, rebuilt the science of the motions of heavenly bodies through the marvelous penetration of his mind, establishing different hypotheses. No one before his time made more accurate speculations on the courses of the stars. For, although he sets up certain notions contrary to the principles of physics, as that the sun is at rest in the center of the universe, that the earth with its mingled elements and with the moon moves around the sun with a triple motion,[7] and that the eighth sphere[8] is stationary, yet he admits nothing unreasonable with reference to mathematical axioms, a defect which may be observed in the Ptolemaic and the traditional hypotheses, if we should examine the matter carefully. For they assume that the motions of the stars in the epicycles and eccentrics are irregular with reference to the center of these circles, which is absurd, and inconsistently, through irregularity, they preserve the regular movements of the stars. All those facts which in our time in regard to the revolutions of the stars we have recognized and accepted were established and handed down to us by these two scholars, Ptolemy and Copernicus. For regarding the contribution made by the investigators of Alphonsus, following Albategnius and others, they do not know that a fundamental treatment of the science is based upon definite observations. Every effort by all means should be made to avoid losing their noble discoveries to the knowledge of men, and to stimulate a careful study of them to the end that they may be fully known. And if there were any deficiencies (and in so perplexing and so exalted a science there must inevitably be) they would be made good by repeated observations of the stars, and by using the observations so as to correct the hypotheses and calculations. Now what can be more difficult than this science? And what can surpass it? It is not concerned with things of the earth, things of the present moment, fluid substances, but with the noble and unchangeable heavenly bodies, and involves the aid of pure thought that requires the keenest acumen and is a source of delight. It is where spring abides ever, where

[7] The first two motions are clearly (1) the movement of the earth on its axis, (2) the movement of the earth around the sun. The third movement is a pure invention of Copernicus, and his exact meaning is obscure. He does not refer to the precessional motion.

[8] The seven spheres are those of the planets. The eighth sphere was conceived by Tycho to be that of the fixed stars, which he regarded together, at one remove from the most distant planet, Saturn.

always

> "The shining sun is seen and kindly day is never darkened; the tempestuous south wind and frenzied north wind are not found there, nor war nor the sword; but everything is done joyously and in peace and order."

How much that heavenly mass surpasses our inferior world below in size, in shape, in the unvarying and marvelous law of its movement, and in its charming beauty! So far ought it be justly and with good reason regarded as more exalted and more splendid than the other sciences, which are concerned with things inferior and perishable. Its lofty dignity is not understood by men of humble capacity and those who, after the fashion of beasts, are chained to earth, but by those in whom there is a fiery spirit and who are heaven sprung. What, pray, can be more charming and more worthy of man than for him to devote his intelligence to the limitless mechanism of the heavens, to the exquisite and wonderful vicissitudes of the shining bodies and of all the stars, and to the felicitous harmonies of their motions. The ignorant indeed see the sun rise and set, the moon wax and wane, the stars shine; but in all this they observe nothing which cannot be seen also by brute animals. They do not see that the sun from its setting to its rising travels in a direction contrary to that of its motion during the day, in an oblique circle, and this indeed unequally, and that by this motion it causes the length of the year and the changes of day and night. They do not notice that the moon travels now more rapidly, now more slowly, that at times it is nearer the earth, at times it is more remote. Moreover they do not consider that the other five planets travel in a direction contrary to that of the daily motion, and that too at different rates of progress, moving now more rapidly, now more slowly, at times even standing still, and that at times they retrace their former paths, and that these same planets, while traversing their courses through the zodiac, variously deviate from the orbit of the sun, as much toward the south as toward the north. These things, I say, and many others, which in the marvelous movements of the heavenly bodies occur with irregularity, men without knowledge of astronomy do not see. Nor if they could see them would they understand the causes of such differences. What person unacquainted with astronomy would know that the sun, which does not seem even as large as the earth, is nevertheless a hundred and sixty times as large as the whole world, while the moon, which appears to be equal in size to the sun, is scarcely as large as one fortieth part of the earth? Who would believe that the other stars are so large that there is scarcely one among the fixed stars visible to the eye that is not several times larger than the earth; while the largest and those of the first magnitude are perceived to be many times larger than the earth? These things, I say, and a great many others, the majority of mankind, who are unfamiliar with astronomy, do not know. And man set in the midst

of this most excellent piece of workmanship wanders like one blind, not understanding the structure and beauty of that home, if I may so call it, which surrounds him. But with his glance on the ground, after the manner of other animals, he pursues only that which is of this earth and ephemeral, sensual pleasures, riches, honors, excesses, and the passing spectacular sights of the world, all of which perish at death. And yet God to him in comparison with animals

> "Has given a noble countenance and has bidden him look at the heavens and raise his face up toward the stars."

Now on the practical advantage of astronomy it is unnecessary to speak at length. For without the intervals of years, months, and days and their definite demarcation, which is due to astronomy, no government, no state can exist, to say nothing of the numerous other admitted advantages which the knowledge of this science contributes to every-day life. But even if it had no practical utility at all, yet the study of it deserves to be cultivated for its own sake by persons of liberal intellect. For it gives pleasure beyond words to man's intelligence, and makes his intellect more alert, and draws the thoughts in which his life consists from the earthly, trivial, and ephemeral to the solemn contemplation of the unchanging heavens. It inspires man himself with genuine pleasure in a manner somewhat like that of the immortals, lifting him out of his mortal existence and transforming him. And so these words of Ptolemy may be spoken to the point not only by their author but by any person acquainted with the divine science of astronomy:

> "Although a mortal I breathe the air of mortals and also am confined by the boundaries of human knowledge, yet, since with mind uplifted I traverse the paths of heaven and the stars revolving with their incessant motions, I am not a mortal nor is my mind debased in mortal body nor does my foot touch the soil of this earth. But, raising my head aloft in the heavens beyond the clouds, I enjoy ambrosia with celestial Jove."

For what purpose would that wise and provident creator of the universe have fashioned laws of the motions of heavenly bodies so marvelous and so enduring, so diversified and yet so harmonious, if he had wished men, for whose sake chiefly he had created the visible world, to remain in ignorance of them. Rather he desired that these matters be diligently studied and investigated so that his majesty and his wisdom also might be seen and honored by men. Therefore, after the true and appropriate recognition of God, who is revealed in the word he has given us, I consider nothing more fitting to the nature of man and more in harmony with the purpose for which man was created and placed on earth, the center of the universe, than that, looking out from his central position as it were at those bodies which shine forth in the entire mechanism of the universe, but particularly in that refulgent realm of the heavens which contains so many everlasting stars, he may pass his

life happily in that delightful and ingenious form of contemplation, and, recognizing God as the creator in these his most wise and varied works, should honor, praise, and reverence him deservedly. For although in this world below there are marvels, witnesses of his divine wisdom, yet nowhere do his wisdom and majesty appear more conspicuously than in that everlasting and boundless theatre of all the stars in heaven. Thus Eobanus has well said:

> "Who denies there is a God, let him look at the heavens and the stars; who sees the stars swears there is a God."

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VIEWS OF MARS WITH A 21-INCH REFLECTOR.

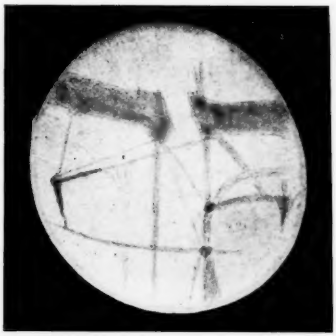
By G. H. HAMILTON.

A change of telescope for each of the last four oppositions of Mars may, or may not, constitute a record; but the results obtained will probably be of interest at some time. This change may be likened to the fluctuations in a variable star. From 1916 to 1922 I was using the 24-inch Lowell refractor; in 1924 the 11-inch Harvard refractor at Woodlawn; in 1926 my observations dropped to the minimum point on the curve—they were obtained with my 8-inch home-made reflector; in 1927 I rose on the curve with a 12-inch reflector, also home-made, but Mars of course was not observed with this; and in 1928-9 my observations were made with a home-made 21-inch, a description of which may possibly be given in a subsequent article.

The three drawings (Plate VII) were made with this 21-inch telescope. Though observing conditions at Mandeville were not particularly good during this opposition, the most noticeable changes that have occurred were easily seen. For the present in my nomenclature I shall use the "General chart of the planet Mars" by Flammarion and Antoniadi. Two regions in particular may be noted—the region of Thaumasia and those of Noachis and Deucalionis taken together; but the changes can best be traced on Schiaparelli's map of Mars for 1881-2.

The Hellespontus in 1924 was not visible as a dark region, or the border of one; but as a distinct canal crossing the large light area south of Pandorae Fretum, then a broad strip filling in the region between Lowell's canal Deucalion and one to the south of it (Lowell's globes of 1903-05). The Sabaeus Sinus made a sharp curve eastward and southward, passing Hammonis Cornu on its way to the south polar regions and following approximately Lowell's canal Dosaron. The Sabaeus at this time was fairly horizontal on the disk. In 1926 this whole region appeared approximately the same, but in 1928-9 the Sabaeus Sinus had a marked southeastward trend (see Schiaparelli's map) and the same sort of configuration was visible, but made up now of the canal Helles-

PLATE VII



Feb. 5, 1929. $\lambda = 245°.2$.
Seeing 6.

Jan. 27, 1929. $\lambda = 352°.2$.
Seeing 7.

Jan. 16, 1929. $\lambda = 57°.4$.
Seeing 6.

DRAWINGS OF MARS BY G. H. HAMILTON.

pontus in its southwestward curve to the polar regions rather than the Dosaron as before. This change entailed a shortening of the Sabaeus Sinus and a broadening of that region known as Hammonis Cornu. At least two of the small oases seen so well in 1924 came down into Aeria to the west of Hammonis Cornu—that is, the easternmost portion of the southward curved end of Sabaeus used two totally different oases in its path across Pandorae Fretum. Pandorae this year though fainter than at the two previous oppositions was still distinctly visible and in the same form.

Thaumasia and the Solis Lacus. The Nectar was the most pronounced canal (or set of canals) crossing Thaumasia in 1924, in fact the Solis Lacus seemed to be simply an enlarged end. In 1926 the Nectar was still visible but fairly faint, the salient feature being a north and south canal crossing the whole of Thaumasia and the Solis Lacus. This was seemingly the start of the canal Fortuna on the map. I find that some late drawings of mine in the opposition of 1924 show this vertical canal in the process of formation. This year the fine canal of 1924 from Lowell's Stagnum Pegasium to the Solis Lacus is the most conspicuous canal in Thaumasia, crossing this region completely with the Solis Lacus as a bulge part way along its length. The action of these large canals springing from the Solis suggests a pinwheel and might be considered a "revolutionary" seasonal effect but for the fact that the 1926 formation was visible in the latter part of 1924 without the intervening angular position just seen at this opposition. A comparison of drawings of all three oppositions is really necessary to the full understanding of what has happened.

It is very curious that the dark regions of the planet in times past considered very nearly permanent in contour—the canals always being named to conform to them—should really turn out to be the only "movable" objects on the disk, taking their form from various arrangements of permanent canals. Any seeming shift of *canals* on the planet, when errors of drawing have been taken into account, can only be accounted for by the use of different canals, these canals always coming from permanent and fixed points. This use of different canals has a curious effect on the drawings made of the planet, for regions that have the appearance of definite and known markings are really other markings in similar form.

For instance, the apparent Nepenthes of all three of the last oppositions is considerably to the north of the real Nepenthes and Lucus Moeris, both faintly visible. It also has an oasis of large proportions upon it—the small oasis Ginea of Lowell, if I am not mistaken—and the canal itself is in reality the continuation of the Eumenides-Orcus through the Hephaestus either way around the globe from Lucus Phoenicis.

However the whole of this is another story.

THE HAMILTON OBSERVATORY, MANDEVILLE, JAMAICA, B. W. I., MARCH, 1929.

AMERICAN ASTRONOMICAL SOCIETY.

(Continued from page 274.)

ULTRA-VIOLET SOLAR RADIATION DURING THE PRESENT SUN-SPOT CYCLE.

By Edison Pettit.

Measurements of the ratio ultra-violet ($0.32\,\mu$) to green ($0.5\,\mu$) solar radiation transmitted by silver and gold, respectively, have been continued. Recent tests of the metallic films show no change in transmissions since the last test nearly two years ago. The atmospheric transmission coefficients are variable only through a small range, and this variability has no relation to the variation in ultra-violet light observed.

The curve of monthly means, smoothed by three-month running averages, shows a considerable correlation with the sun-spot curve treated in like manner. The major fluctuations may be seen in both curves. Taking the ratio for June, 1924, as unity, the maxima since that date occurred on two occasions, 1.5 in October, 1925, and 1.5 in February, 1927, in the smoothed curve, and 1.56 and 1.50 in the monthly means. The lowest value 1.14 for the smoothed curve and 1.12 for the monthly averages was reached in September, 1928. The curve is now on the up trend reaching 1.21 in the smoothed curve and 1.30 in the monthly average. It is to be noted that the oscillations of the monthly averages from the smoothed curve are less for the ultra-violet solar radiation than for the sun-spot counts.

TEMPERATURES ON THE MOON.

By Edison Pettit and Seth B. Nicholson.

A determination of planetary temperatures depends practically on the elimination of reflected light by means of a microscope cover-glass 0.165 mm thick which is superior to the water cell since no assumption of spectral distribution of reflected light is necessary. From the transmission of the atmosphere and the reflecting power of silver we have computed the radiometric magnitude of a solid angle of one square second of planetary radiation for various temperatures observed with a Newtonian telescope. The temperatures are read from this curve after the planetary heat is separated from the reflected light measured by the thermocouple.

Temperature of the sub-solar point. The emission of a uniformly heated surface presenting a given solid angle of radiation is independent of the angle of projection. This principle we have tested in the lab-

oratory. However, temperatures of the sub-solar point on the moon measured when it is near the center of the disk at full moon average within a few degrees of 400° K as against 355° when it is near the center of the limb at first or last quarter. These temperatures are reduced to a solar constant on the moon of 1.93 cal cm^{-2} min^{-1} and the observations were made over the period March 24, 1923, to July 5, 1927.

Distribution of Radiation and Temperature over the Lunar Surface. The distribution of radiation and temperature over the lunar surface was measured by taking drift curves on several occasions during this period. These were measured and plotted both for planetary heat and temperature. The curve of distribution of planetary heat along a diameter when reduced to the condition that the sub-solar point is central on the disk is a nearly symmetrical figure, following approximately the theoretical cosine law of distribution, but showing a distinct tendency to run too high in the region 45° (0.7 radius) from the sub-solar point. This phenomenon, like the low temperature of the sub-solar point measured at first or last quarter phase, can be explained as due to roughness of the lunar surface. The temperature at the sub-solar point is 400° K, just above the melting point of sulphur, at 0.5 radius from this point 395° K, at 0.75 radius 375° K and at 0.9 radius 350° K.

Over one-eighth the entire area of the moon, an area about 1600 miles in diameter in the middle of the illuminated side, the temperature is always above the boiling point of water, 373° K.

Lunar Radiation and Temperatures during the eclipse of June 14, 1927. A point on the moon 2′ from the south limb was chosen for continuous measurement since this point travelled over the greatest chord in passing through the earth's shadow. For this point the durations of the partial phases were 1 hour each and for the total phase $2^h\ 40^m$. The temperature was 342° K before eclipse, and began to drop immediately on striking the penumbra, reaching 210° K at the beginning of totality and 170° K twenty minutes later. At the end of the total phase it was 152° K. This temperature did not change greatly until twenty minutes after totality when it rose rapidly from 160° K to 330° K in the next half hour. The planetary radiation during the first partial phase is nearly given by

$$h = (0.44\,H + 0.17)\ \text{cal cm}^{-2}\ \text{min}^{-1}$$

where h is the heat radiated by the moon and H is the heat received by it from the sun. During the total phase it is

$$h = (0.065 - 83t \times 10^{-6})\ \text{cal cm}^{-2}\ \text{min}^{-1}$$

where t is the time in minutes elapsed, counted from a half hour after totality began. For twenty minutes after totality the planetary radiation rose only slowly, but after this time it is expressed by

$$h = (1.1\,H - 0.81)\ \text{cal cm}^{-2}\ \text{min}^{-1}$$

From these data it appears that about 1.1 cal cm^{-2} min^{-1} is absorbed by the moon's surface, but balanced by re-radiation, that about 0.1 cal cm^{-2}

min^{-1} or six per cent of the radiation received is conducted into the moon's surface at the beginning of eclipse, and about 0.044 cal cm^{-2} min^{-1} is conducted out of the surface at the end of the total phase.

A NEW MICROMETER.

By E. D. Roe, Jr.

A micrometer has been constructed for the recently remounted 8-inch Clark refractor of the Holden Observatory of Syracuse University, to satisfy the following requirements:

1. The value of one turn of the screw to be close to 20″, so as to give a decimal system and dispense with the use of tables for evaluating measures, taken by double distances in double star work, for separations up to 10″.

2. By means of a device for securing a second rotation, the position circle being clamped at 90°, for correct adjustment in the telescope, position angles are to be read off directly and without correction, for the otherwise erroneous position of the micrometer in the eye end of the telescope.

3. A left handed instead of a right handed screw for shifting the micrometer box.

4. Reading lenses and lamps for the verniers, the lamps to be illuminated by the same current which illuminates the lamp for the inside spider threads, a switch shifting the current alternately from one to the other as needed.

5. Five positive eyepieces of equivalent focal lengths 1.3, 1, ½, ¼, ⅛ inches, the 1.3-inch with wider field being for direct micrometrical observations of the sun, or comets, and the ⅛-inch being for double star work. An average of 95 transit observations for determining the value of one turn of the screw gives preliminarily $r = 20''.0890$, with $r/2 = 10''.0445$. An average of 460 transits gives as the value of one turn of the screw of the Gaertner micrometer of the 6½-inch Clark refractor of the Roe Observatory, which was used on the 8-inch refractor in order to obtain the necessary specifications for the screw of the new micrometer, $r = 20''.0058$, $r/2 = 10''.0029$.

6. A clamp for the position circle.

These conveniences make rapid and agreeable observations possible in double star work.

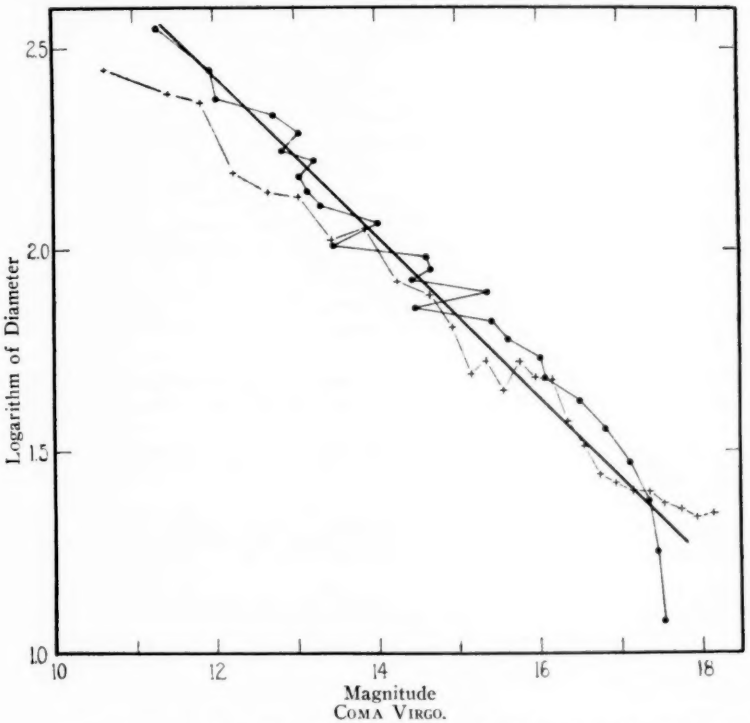
The construction of the micrometer and details was executed by the Gaertner Scientific Corporation, to whom great credit is due for their mechanical skill in meeting the various demands.

ON THE TRANSPARENCY OF INTER-GALACTIC SPACE.

By Harlow Shapley and Adelaide Ames.

The determination of the apparent photographic magnitudes and the apparent diameters of 2750 extra-galactic nebulae in the Coma-Virgo

region permits the deduction that the total obstruction of light in crossing thirty megaparsecs is not in excess of half a magnitude and is probably wholly negligible. The extra-galactic systems measured belong to at least four different groups at greatly differing distances, and the relation, $d = 10^{-0.2m}$, between diameter and apparent magnitude, which should hold in the absence of light scattering, is maintained from one group to another.



COMA VIRGO.

The accompanying plot of apparent magnitude against the logarithm of the apparent diameter indicates the representation of the regression curve by the theoretical relation (straight line). For nearer parts of space, the effective absence of light obstruction (except in obviously obscured regions) is shown by a similar plot for globular clusters of Classes I to VIII, but the data are much less numerous than for extra-galactic nebulae, and both the apparent diameters and the magnitudes are much less certainly measured.

RECENT PHOTOGRAPHIC OBSERVATIONS OF MARS, VENUS, MERCURY, JUPITER, AND SATURN.

By E. C. Slipher.

This paper dealt with recent color-filter photography of the planets at the Lowell Observatory with various filters transmitting different parts of the red, yellow, and violet of the spectrum. The photographs illustrating the paper were secured with the 24-inch refractor and cameras magnifying 215 and 175 times, a correcting lens being employed, as previously, for the blue and violet images.

Perhaps the most noteworthy event in recent planetary study is the extraordinary development which took place during September and October, 1928, in the south equatorial and south tropical belts of Jupiter and which was clearly portrayed by the slides. The revival of activity in this region, which for about two years had been a broad expanse of white except for the Red Spot whose reddish color has been unusual, began in the form of a row of dark spots strung like beads on a fine line lying in latitude 18° S, but later the disturbance gave rise to numerous dark and bright spots eventually encompassing this whole zone and of such turbulent character as to show discernible differences from night to night. The first dark spots appeared in the latitude of the Red Spot and showed a rapid change in longitude (System II) resulting in an unprecedented rotation period of about $9^h\,59^m$, which caused them to approach the Red Spot at the rate of 3700 miles per day.

Other periods of unusual activity appear to have occurred on the planet in 1920, a less marked one in 1913, and another in 1904-5, according to the photographic record secured at Flagstaff, which is somewhat suggestive of an eight-year periodicity. Attempts to trace recurrences of disturbances such as these in the earlier visual observations has not as yet been very successful. The possible relation of these Jovian commotions to other influences in the solar system is also obscure but one might venture to mention that unusual auroral displays were observed during the period of these Jovian disturbances.

Red, yellow, and violet photographs of Saturn in 1928 brought out changes on the ball since 1927 and showed the ball darker than the rings in violet light, while in red it was somewhat brighter than the rings, evidencing that the ball was suffused with a reddish light, especially in the equatorial and tropical zones, which was not present in the rings. The violet images showed a dark sash across the equator and a bright band in the temperate zone neither of which was visible in the red and yellow. These differences seem attributable to color variations in the Saturnian atmosphere.

The ultra-violet slides of Venus showed the bright and dark markings characteristic of this planet when photographed in deep violet or

ultra-violet light. Systematic photographic study shows that these markings vary greatly from day to day, frequently appearing or disappearing between daily observations. This tends to confirm the opinion that they are entirely atmospheric. Such variation in the surface markings offers some explanation for the marked variations in the radiometric measures of the disk observed here for some years.

Examples of yellow and violet photographs of Mercury, the first ever obtained, were shown. Some faint markings have been recorded but the matter of photographing a planet so near the sun by using violet light is difficult and the observational material is too meager as yet for general discussion.

Sets of blue and yellow photographs of Mars taken at monthly intervals displayed many changes especially over the polar regions, characteristic of the Martian season (the equinoxes). The south pole, just entering the autumn season, was generally brighter in yellow light as if veiled by yellowish haze or clouds, while the north pole, in early springtime, was strikingly brighter in blue pictures as if covered by frost or snow. Considerable change was noted, too, in many of the dark markings as compared with 1926 and 1924, the outstanding example being a dark band running across the disk about twenty degrees south of the Sabaeus Sinus and which showed much more prominently than anything depicted there in any previous observations of the planet. However, the general aspect of the planet was about as expected at this Martian season, the dark markings appearing fainter than usual and this effect seemed augmented by a somewhat general veiling of the surface as if by a hazy condition of the Martian atmosphere. The temporary bright spots so frequently recorded in blue photographs in 1926 and earlier, here, were rarely observed in 1928, but earlier work has indicated their seasonal character.*

EMISSIONS OF THE SPECTRUM OF THE NIGHT SKY.

By V. M. Slipher.

At the Lowell Observatory and at its mountain station (altitude 11,500 feet), the study of the spectrum of the night sky has been extended with highly efficient equipment including a new spectrograph of exceptional light-power. Numerous lantern slides were used in showing the results.

The spectra of the auroras of July 7 and October 18, 1928, were recorded on panchromatic plates revealing the fact that the red emission near $\lambda 6320$ was, in both, far the strongest emission in the whole aurora spectrum.

The earlier observations of the spectrum of the blue and violet light of the night sky, which revealed here in 1922 remarkable spectral

*See Popular Astronomy, **29**, 69, 1921; also *Publ. A.S.P.*, June, 1921, and August, 1927.

features, have since been extended to include the yellow and red region, with fruitful results. These yellow-red spectrograms have disclosed numerous sky emissions of great strength and indicate still others farther into the red.

Fortunately it was possible to photograph, at the mountain station, these new emissions of the usual sky on the same plate with spectrum exposures of the auroral display of October 18, and thus to make evident what emissions the two sources seemed to have in common; namely, only the red aurora emission about λ6320. These sky emissions have been recorded for several months (since suitable plates were employed), one of them since 1922, and are regarded as permanently present. That they vary appears to be established and perhaps they do so in somewhat the manner that the permanent yellow aurora line varies, but apparently they do not fluctuate with it.

Because the dispersion of the instrument is low and the wave-lengths of these new emissions are now only approximately determined, there is as yet no proper basis for identification work. However, one of this group of emissions appears to fall very near to—and possibly coincident with—the sodium [D]. The laboratory line at λ6655 to which Kaplan has drawn attention, if present, is obscured by other prominent emissions.

Most of the spectrograms in this work were secured with the instrument pointed to the sky near the north pole, but some were secured with other sky pointings. There is every reason to expect to find that these new emissions are present over the whole sky, just as was found here to be the case with the emissions of the blue and violet portion of the night sky spectrum and also with the permanent yellow auroral line of the sky. While it cannot now be definitely decided, it appears probable that these sky emissions originate mainly in the Earth's atmosphere. It will be seen that this work throws light on the origin of the puzzling results secured by some investigators of the general illumination of the night sky in studies on the total light of all the stars.

THE PARALLAX OF 17 LYRAE C.

By Frederick Slocum.

The components A and B of 17 Lyrae are of magnitudes 5 and 11, separated by 3″.7. The proper motion of AB is 0″.132 in the direction 76°. B is moving very slowly relative to A, thus making this system similar to 61 Cygni. The star C is nearly 3′ from AB. It has a proper motion of 1″.658 in 48°.

The parallax of C was first determined by the writer at the Yerkes Observatory in 1911, but on account of the small number of plates used and the lack of precautions as to hour angle and diameter of image, the

Twenty-seven plates, with 54 exposures, have been taken at the Van Vleck Observatory, extending over six epochs. Five comparison stars

result was considered rather weak.

were used. Their mean diameter is 0.08 mm; that of the parallax star is 0.07 mm.

RESULTS.

Parallax of 17 Lyrae C	$+0''.132 \pm 0''.009$
Proper motion, east	$+1''.237 \pm 0''.009$
Probable error, unit weight	$\pm 0''.035$

The east component of Burnham's proper motion is 1".236.

From the proper motions and parallaxes it is evident that C is not physically connected with AB.

The value of the parallax obtained by the writer at the Yerkes Observatory is $+0''.124 \pm 0''.008$. The only other value thus far published is by van Maanen, $+0''.109 \pm 0''.008$. From plates taken with the 2-ft. reflector of the Yerkes Observatory the magnitude of C was found to be, visual 11.3, photographic 12.5. The spectrum was found at Mount Wilson to be Ma, agreeing well with the color index indicated above. Using the visual magnitude and the Van Vleck parallax, the absolute magnitude comes out 11.9 and luminosity 0.0015 sun, making 17 Lyrae C a typical red dwarf.

THE PARALLAX OF 61 CYGNI.

BY CARL L. STEARNS.

The parallax of this well-known star was determined at the Van Vleck Observatory from twenty-two plates taken in eleven seasons from 1922 to 1928. The reductions were carried out by the dependence method in the usual way, with four comparison stars. The least-squares solution gave the following results:

	Brighter	Fainter
π =	$+0''.296 \pm 0''.008$	$+0''.302 \pm 0''.008$
μ_x =	$+4''.133 \pm 0''.003$	$+4''.127 \pm 0''.004$
Probable error for unit weight =	$0''.028$	$0''.028$

Two early plates and two late plates were measured in both coördinates in order to determine the total proper motion, which was found to be 5".271 in position angle 51°.8 for the brighter component and 5".162 in position angle 53°.0 for the fainter component.

Modern photographic determinations of the parallax of 61 Cygni by other observers range from 0".267 to 0".325, if the two components are considered separately, and the *Yale Parallax Catalogue* gives $0''.300 \pm 0''.003$ as the mean absolute parallax of the system.

A comparison of recent micrometric and photographic measures of position angle and distance, including those from six of the Van Vleck observatory plates, with the position given by C. F. W. Peters' orbital elements (*A.N.*, **113**, 320) computed in 1885, shows good agreement. A reduction of 0".27 in the semi-major axis represents somewhat more closely the whole series of observations from 1830 to 1928.

(To be continued.)

PLANET NOTES FOR JULY AND AUGUST.

By CLIFFORD E. SMITH.

The *Sun* during these months will be moving southeast from the central part of Gemini, across Cancer, to the central part of Leo. On July 4 the earth will be at aphelion, or the sun will be farther from the earth than at any other time during the year. The position of the sun on July 1, Aug. 1, and Aug. 31 will be, respectively: R.A. $6^h\ 38^m$, Decl. $+23°\ 10'$; R.A. $8^h\ 43^m$, Decl. $+18°\ 13'$; R.A. $10^h\ 35^m$, Decl. $+8°\ 55'$.

The phases of the *Moon* will occur as follows:

New Moon	July	6 at	3 P.M.	C.S.T.
First Quarter		13 "	10 A.M.	"
Full Moon		21 "	1 P.M.	"
Last Quarter		29 "	7 A.M.	"
New Moon	Aug.	4 "	10 P.M.	"
First Quarter		11 "	12 P.M.	"
Full Moon		20 "	4 A.M.	"
Last Quarter		27 "	2 P.M.	"

The moon will be at perigee (nearest the earth) on July 6, August 3, and August 31, and at apogee (farthest from the earth) on July 19 and August 16.

Mercury during this period will move from the eastern part of Taurus, across Gemini, Cancer, and Leo, to the western part of Virgo. Its apparent motion in the sky will be direct. On July 3 Mercury will be at greatest elongation west, and on this date it will rise approximately an hour and a half before the sun. On July 22 Mercury will pass through perihelion, and on July 31 it will be at superior conjunction. Also on August 5 Mercury will be in conjunction with the moon, and on August 11 with Neptune. At the end of August Mercury will set about an hour and a half after the sun.

Venus will be moving in an easterly direction across Taurus and Gemini to the eastern border of Gemini, and its apparent motion will be direct. During July Venus will rise about three hours before the sun, and during August it will be somewhat nearer the sun. On July 14 Venus will be in conjunction with Jupiter.

Mars, on the first of July, will be in Leo less than a degree from Regulus, but during this period it will move to the central part of Virgo. On July 3 Mars will be in conjunction with Neptune, and they will be rather close, the angular distance between them being about equal to the diameter of the moon. On July 10 and August 7 Mars will be in conjunction with the moon. At the beginning of July Mars will set about three and a half hours after the sun, and at the end of August about two hours after the sun.

Jupiter will be in the central part of Taurus, and its apparent motion will be direct. At the beginning of this period it will rise about two and a half hours before the sun, and at the end of this period it will be approaching quadrature west. On July 14, as has been mentioned, Jupiter will be in conjunction with Venus.

Saturn will be in the southern part of Ophiuchus, and its apparent motion will be retrograde until August 29. Early in July it will be on the meridian about 11:00 P.M., Standard Time, approaching quadrature east near the middle of September. On July 19 and on August 15, Saturn will be in conjunction with the moon.

Uranus will be in the western part of Pisces. Its apparent motion will be direct until July 17, when it begins a period of retrograde motion. On July 27 and on August 23 Uranus will be in conjunction with the moon. During the first part of July Uranus will be near the meridian at sunrise since it will be in quadrature west of the sun on July 3.

Neptune will be in Leo. At the beginning of July it will be about fifty degrees east of the sun, and it will be approaching conjunction which will occur on August 24. As has been mentioned, Neptune will be in conjunction with Mars on July 3 and with Mercury on August 11.

Occultations Visible at Washington.

[From the *American Ephemeris.*]

Date 1929	Star's Name	Magnitude	IMMERSION Washington C.T.	IMMERSION Angle from N	EMERSION Washington C.T.	EMERSION Angle from N	Duration
			h m	°	h m	°	h m
July 4	κ Tauri	4.1	3 19	98	4 4	219	0 45
4	67 Tauri	5.4	3 24	124	3 54	193	0 30
4	υ Tauri	4.2	4 12	352	4 26	323	0 13
11	10 Virginis	6.2	22 26	205	22 30	213	0 4
22	56 B. Capric.	6.3	4 50	42	5 49	270	0 59
23	35 Capric.	6.0	2 30	119	3 11	180	0 42
26	376 B. Aquarii	6.3	2 0	45	3 23	238	1 23
27	14 Ceti	5.4	2 35	65	3 54	215	1 18
Aug. 1	99 Tauri	6.0	1 0	135	1 22	191	0 23
20	161 B. Capric.	6.4	2 26	77	3 33	216	1 8
22	351 B. Tauri	6.5	2 13	2	3 8	278	0 55
27	284 B. Tauri	6.0	23 25	98	0 11	223	0 46
28	95 Tauri	6.2	2 18	64	3 24	249	1 6
29	125 Tauri	5.1	0 0	76	0 50	257	0 50
31	4 Cancri	6.2	4 39	96	5 44	270	1 5

VARIABLE STARS.

Monthly Report of the American Association of Variable Star Observers, for the Month of April, 1929.

On April 21 news was received at the headquarters of the Association of the passing of S. Lynn Rhorer, late of Atlanta and Miami. Mr. Rhorer had been seriously ill for several months, but reports from Atlanta had led us to believe that he was on the road to recovery. The news came as a sad blow to many of his numerous friends both in and out of the ranks of the Association. Mr. Rhorer had been for many years a Life Member of the AAVSO and during the earlier years of his membership was an active observer and a member keenly interested in the welfare of the Association. His greatest interest was of course his Southern Cross Observatory which he personally conducted during the winter months at Miami, Florida. There he had set up a battery of 5-inch telescopes, adding one each year, until the number seven was reached this year. In his passing the Association has suffered an incalculable loss.

We are pleased to note the return to our observing ranks of Mr. D. F. Brocchi of Seattle, Washington. Mr. Brocchi has for the past few years been

VARIABLE STAR OBSERVATIONS RECEIVED DURING APRIL, 1929.

Feb. 0 = J.D. 2425643; Mar. 0 = J.D. 2425671; April 0 = J.D. 2425702.

J.D.Est.Obs.	J.D.Est.Obs.	J.D.Est.Obs.	J.D.Est.Obs.	J.D.Est.Obs.	J.D.Est.Obs.
V SCL	W SCL	U SCL	U PER	R FOR	T HOR
000339	*002833*	*010630*	015254	*022426*	*025751*
614 12.8 Bl	614 13.0 Bl	614 13.2 Bl	687 7.9 Ah	620 9.3 Bl	647 9.6 Bl
626 12.9 Bl	647 13.0 Bl	647[13.2 Bl	688 7.9 Ah	626 8.7 Bl	649 9.8 En
645[13.3 Bl	Y CEP	671[13.0 Dr	689 8.0 Ah	634 9.0 Bl	650 9.6 Ht
S SCL	003179	U AND	692 8.0 Ah	647 9.2 Bl	654 9.1 Sm
001032	677 12.4 L	010940	693 8.0 Ah	655 9.0 Bl	655 8.6 Bl
620 9.4 Bl	685[13.6 L	673 11.7 Ch	699 8.0 Pt	662 8.8 Bl	661 8.5 Sm
626 9.7 Bl	U CAS	678 11.6 L	R ARI	RR CEP	661 8.8 Ht
634 9.7 Bl	004047	680 11.8 B	021024	022980	663 8.0 Bl
645 10.6 Bl	673[12.6 Ch	685 11.8 L	671 11.2 Ch	674[12.9 Ch	669 8.9 Dr
645 10.2 Sm	678 13.9 L	UZ AND	672 11.4 Ah	678 13.1 L	670 8.4 Ht
649 10.5 En	RW AND	011041	673 11.5 Ch	R TRI	673 8.6 Dr
650 10.5 Ht	004132	673 11.2 Ch	685 12.6 Ch	023133	678 8.8 Dr
654 11.1 Sm	673[12.6 Ch	678 11.0 L	W AND	661 8.6 Gy	682 8.7 Dw
655 11.0 Bl	678[13.5 L	685 10.8 L	021143a	672 8.4 Ah	684 9.0 Dr
682 12.5 Dw	V AND	S PSC	671 11.2 Ch	673 8.3 Ah	U ARI
X AND	004435	011208	673 11.0 Ch	684 7.5 Pt	030514
001046	648 14.3 Nz	679[13.0 L	T PER	685 7.5 Ah	648 13.9 Nz
648 14.9 Nz	X SCL	S CAS	021258	687 7.4 Ah	667 12.7 Nz
672[12.1 Lj	*004435*	011272	672 8.6 Ah	688 7.3 Ah	671 12.3 Nz
T CAS	614[13 6 Bl	674 12.4 Ch	684 8.6 Pt	689 7.1 Ah	671 12.6 Ch
001755	647 13.8 Bl	680 12.8 B	Z CEP	690 7.0 Ah	679 12.2 L
673 11.8 Ch	655 12.5 Bl	699 13.0 Pt	021281	691 7.1 Wn	X CET
678 12.0 L	RR AND	U PSC	678 12.5 L	693 6.8 Ah	*031401*
684 12.1 Pt	004533	011712	685 11.6 L	698 6.6 Sf	677 11.9 L
692 11.7 L	648 13.1 Nz	679[13.5 L	699 10.4 Pt	709 5.8 Sf	685 11.5 L
R AND	677 10.6 L	RZ PER	709 11.1 Sf	W PER	Y PER
001838	685 9.6 L	012350	o CET	024356	032043
673 11.8 Ch	RV CAS	673 10.5 Ch	*021403*	679 10.4 Ch	684 10.1 Pt
S TUC	004746a	677 10.1 L	649 9.1 En	684 9.8 Pt	685 10.0 Ch
001862	678 13.1 L	692 10.6 L	654 8.8 En	687 9.8 B	692 10.0 B
620 12.7 Bl	692 11.3 L	R PSC	672 9.4 Ah	706 9.6 B	R PER
647 13.5 Bl	699 11.4 Pt	012502	678 9.3 L	R HOR	032335
647 12.4 En	— CAS	648 11.1 Nz	684 9.8 Ch	*025050*	671 12.5 Ch
650[13.2 Ht	004746b	671 12.0 Nz	685 9.4 L	620 9.4 Bl	679 12.8 L
654[13.2 En	678 10.8 L	RU AND	S PER	626 8.7 Bl	690 13.3 Lg
661[12.4 Ht	692 10.5 L	013238	021558	634 7.6 Bl	702 13.6 Lg
680[13.2 Ht	699 10.8 Pt	669 11.0 Ch	672 9.2 Ah	647 7.3 Bl	T FOR
T SCL	W CAS	678 10.5 L	684 8.7 Pt	649 7.0 En	*032528*
002438a	004958	685 10.5 L	687 9.3 B	650 6.8 Ht	678 9.2 L
671 12.5 Dr	699 10.7 Pt	699 10.5 Pt	706 9.2 B	654 6.6 Sm	685 8.7 L
682 12.9 Dw	U TUC	Y AND	709 9.9 Kl	655 7.4 Bl	U ERI
RR SCL	*005475*	013338	R CET	661 6.0 Sm	*034625*
002438b	620 9.4 Bl	669 9.5 Ch	*022000*	661 6.8 Ht	674 14.5 Dr
671 13.0 Dr	626 8.6 Bl	678 10.2 L	672 8.5 Ch	669 6.9 Dr	687 14.8 Dr
T PHE	634 8.3 Bl	680 10.6 B	677 8.4 L	670 6.5 Ht	687 15.1 Dw
002546	645 8.9 Sm	685 10.9 L	684 8.4 Ch	671 6.8 Dr	T ERI
620 11.2 Bl	646 8.7 Bl	699 12.2 Pt	685 8.3 L	673 6.9 Dr	*035124*
626 11.3 Bl	649 8.8 En	X CAS	RR PER	678 6.9 Dr	669 8.0 Dr
634 11.8 Bl	650 8.6 Ht	014958	022150	682 6.9 Dw	673 7.8 Dr
645 12.4 Sm	654 8.7 Sm	699 11.8 Pt	671[13.5 Ch	682 7.1 Dw	682 7.5 Dw
646 12.5 Bl	655 8.8 Bl	U PER	678 14.1 L	684 6.7 Dr	W ERI
649 12.6 En	661 9.2 Ht	015254	698[12.3 Ty	691 6.9 Dr	*040725*
650 13.2 Ht	661 8.9 Sm	672 8.0 Ah	703[11.7 Ty	T HOR	669 9.1 Dr
654 13.0 Sm	662 9.0 Bl	673 7.9 Ah	708[12.3 Ty	*025751*	678 9.8 Dr
671 13.5 Dr	670 9.5 Ht	681 8.1 Ah	711[12.3 Ty	620 11.0 Bl	682 9.2 Dw
		684 9.4 Ch	712[12.3 Ty	626 10.7 Bl	684 9.9 Dr
		685 8.1 Ah		634 10.2 Bl	

VARIABLE STAR OBSERVATIONS RECEIVED DURING APRIL, 1929.

J.D.	Est.	Obs.	J.D.	Est.	Obs.	J.D.	Est.	Obs.	J.D.	Est.	Obs.	J.D.	Est.	Obs.	J.D.	Est.	Obs.
R TAU			**R DOR**			**R ORI**			**R AUR**			**W AUR**			**AN ORI**		
042209			*043562*			045307			050953			052036			*053005t*		
648	12.0	Nz	620	5.5	Bl	698	11.6	Ty	709	8.2	Kz	686	12.0	Be	690	11.3	L
667	12.4	Nz	626	5.5	Bl	701	11.9	B	**T PIC**			686	12.2	An	691	11.5	L
671	12.7	Nz	634	5.2	Bl	708	11.7	Wn	*051247*			696	12.1	Ty	692	11.5	L
671	12.8	Ch	647	5.0	Bl	708	12.2	Ty	620	9.1	Bl	698	12.5	Sf	699	11.7	L
691[	10.6	Ty	650	5.6	En	711	12.1	Ty	626	9.0	Bl	699	12.8	L	702	11.6	L
698[	12.0	Ty	650	5.4	Ht	712	12.2	Ty	634	8.9	Bl	699	12.6	An	**S CAM**		
707[	13.2	B	654	5.2	Sm	**ε AUR**			647	8.9	Bl	699	12.7	Be	053068		
711[	12.0	Ty	656	5.8	Bl	045443			649	8.8	En	701	12.3	B	673	8.8	Ah
712[	12.0	Ty	661	5.5	Ht	689	4.1	Be	650	9.2	Ht	702	12.4	Lg	687	8.8	Ah
W TAU			661	5.2	Sm	690	4.1	Be	656	9.1	Bl	**CI ORI**			688	8.5	Ah
042215			663	5.5	Bl	696	4.2	Be	658	9.2	Sm	*052401*			689	8.7	Ah
684	9.6	Pt	669	5.4	Dr	701	4.1	Be	659	9.1	En	680	10.1	Wy	699	8.1	Pt
690	9.9	Lg	670	5.5	Ht	**R LEP**			661	9.7	Ht	**S ORI**			**RR TAU**		
692	9.6	B	680	5.4	Dr	*045514*			663	9.4	Bl	*052404*			053326		
702	10.2	Lg	691	5.4	Dr	677	8.5	L	669	9.6	Dr	684	10.0	Pt	667	11.1	Nz
708	10.6	B	**R CAE**			694	8.6	Pt	670	10.2	Ht	692	10.0	B	671	10.9	Nz
S TAU			*043738*			692	8.5	L	680	10.3	Dr	699	9.8	An	687	11.2	B
042309			620	12.2	Bl	**V ORI**			682	10.5	Dw	699	9.8	Be	**RU AUR**		
648[	14.8	Nz	626	12.3	Bl	050003			684	10.8	Dr	**T ORI**			053337		
667[	13.9	Nz	647	12.7	Bl	671	12.4	Ch	Nov		TAU	*053005a*			690	13.0	Lg
671[	14.8	Nz	650[	12.0	Ht	684	11.4	Pt	051316			677	11.0	L	698	12.2	Sf
707[	13.2	B	658[	12.0	Sm	690	10.6	Lg	678	13.2	L	678	10.9	L	702	11.9	Lg
708[	12.0	Wd	661[	12.0	Ht	701	10.7	B	**T COL**			679	10.7	L	709	11.6	Sf
711[	12.0	Wd	669[	12.8	Dr	702	10.3	Lg	*051533*			680	10.1	Wy	709	11.5	Kz
712[	12.0	Wd	670[	11.7	Ht	**T LEP**			620	10.6	Bl	681	9.7	L	711	11.7	Lg
T CAM			674	14.2	Dr	*050022*			626	9.8	Bl	684	9.8	L	**U AUR**		
043065			682[	13.5	Dw	620	8.6	Bl	634	9.1	Bl	685	9.7	L	053531		
679	14.0	L	687	14.8	Dw	626	8.4	Bl	645	9.2	Sm	686	9.8	An	671	9.0	Ch
685	13.9	L	687	13.7	Dr	634	8.5	Bl	647	8.7	Bl	686	9.5	Be	672	9.3	Ah
691[	12.7	An	**R PIC**			647	8.7	Bl	649	8.6	En	687	10.2	B	673	9.3	Ah
694[	10.5	BL	*044349*			648	9.6	Nz	650	8.9	Ht	689	10.6	Pt	680	9.4	B
699	13.2	Pt	620	7.5	Bl	656	8.8	Bl	656	8.4	Bl	690	10.4	L	684	9.5	Pt
708	12.0	BL	626	7.5	Bl	663	9.4	Bl	658	8.3	Sm	690	10.5	Lg	685	9.3	Ah
RX TAU			634	7.6	Bl	671	9.9	Nz	659	8.4	En	691	10.1	An	687	9.5	Ah
043208			646	7.7	En	684	10.5	Pt	661	8.4	Ht	691	10.2	Be	689	9.7	Sf
677	13.9	L	647	7.9	Bl	692	10.2	B	663	8.4	Bl	691	10.4	L	698	10.2	Sf
707[	12 5	B	650	8.5	Ht	**S PIC**			669	7.9	Dr	692	10.0	L	706	9.7	B
R RET			654	8.0	En	*050848*			670	7.9	Ht	697	9.7	Pt	709	10.6	Kz
043263			654	7.9	Sm	620	11.7	Bl	673	8.0	Dr	698	9.8	Pt	709	10.6	Sf
620	11.2	Bl	656	8.0	Bl	626	11.6	Bl	680	7.5	Dr	698	9.7	An	710	11.2	Am
626	11.4	Bl	661	8.0	Ht	634	12.0	Bl	684	7.6	Dr	699	9.6	An	**Y TAU**		
634	11.7	Bl	661	7.8	Sm	647	12.2	Bl	686	7.4	Dw	699	9.6	Be	053920		
647	11.9	Bl	663	8.6	Bl	649	12.2	En	691	7.4	Dr	699	9 9	Pt	698	7.2	Kl
650	12.4	En	669	7.9	Dr	654[	12.2	Sm	**S AUR**			699	9.7	L	707	7.3	Kl
650	12.5	Ht	670	8.7	Ht	659[	12.2	En	052034			701	10.2	Pt	709	7.6	Kl
654	12.4	Sm	673	8.0	Dr	661[	12.2	Sm	680	10.0	Wy	702	10.0	L	**SU TAU**		
656	12.4	Bl	680	8.1	Dr	**R AUR**			684	9.0	Pt	702	10.0	Lg	054319		
669	12.7	Dr	682	8.4	Dw	050953			686	10.1	An	705	10.6	Pt	677	13.3	L
680	13.2	Dr	684	8.4	Dr	671	9.3	Ch	686	9.6	Be	708	10.5	Pt	678	13.1	L
682	12.6	Dw	**V TAU**			673	9.3	Ah	698	10.3	An	711	10.3	Lg	679	13.1	L
684	13.5	Dr	044617			680	9.4	B	698	9.5	B	**AN ORI**			680	12.8	B
X CAM			671[	13.0	Ch	684	9.1	Pt	709	9.0	Pt	*053005t*			681	12.9	L
043274			699[	13.8	B	685	9.3	Ah	**W AUR**			677	11.7	L	682	12.7	Br
674	9.4	Ch	**R ORI**			687	9.3	Ah	052036			678	11.7	L	684	12.2	Br
679	9.4	L	045307			688	8.9	Ch	671	11.8	Ch	679	11.7	L	684	12.4	L
690	8.1	L	674	11.4	Ch	692	9.3	Ah	677	11.7	L	681	11.8	L	685	12.5	L
699	9.0	Pt	677	12.0	L	698	9.0	B	684	12.2	Pt	684	11.8	L	685	12.4	B
701	9.1	B	685	12.1	L	702	8.6	Lg	685	12.1	L	685	11.8	L	690	12.2	L

VARIABLE STAR OBSERVATIONS RECEIVED DURING APRIL, 1929.

J.D.Est.Obs.	J.D.Est.Obs.	J.D.Est.Obs.	J.D.Est.Obs.	J.D.Est.Obs.	J.D.Est.Obs.
SU TAU	α ORI	X AUR	Y MON	L_2 PUP	S VOL
054319	054907	060450	065111	*071044*	*073173*
692 11.8 L	677 0.8 L	689 10.2 Lj	673 9.1 Ch	669 3.1 Dr	661 11.4 Ht
692 11.8 B	685 0.8 L	691 10.2 Lj	684 9.2 Pt	671 2.8 Dr	663 12.0 Bl
697 11.0 Pt	698 0.8 An	697 9.8 Lj	685 9.6 B	673 2.7 Dr	670 11.8 Ht
698 11.0 Pt	U ORI	698 9.5 B	706 10.5 B	673 2.7 Dw	671 11.9 Dr
698 11.0 B	054920a	699 9.0 Pt	711 10.8 Lg	674 2.7 Dr	680 12.0 Dr
698 11.2 Sf	671 9.7 Ch	700 9.7 Lj	X MON	677 2.8 Dr	686 12.2 Dw
699 11.0 Pt	673 9.4 Ah	707 9.2 B	*065208*	680 3.0 Dr	U CMI
699 10.7 L	684 10.1 Pt	708 9.3 Wn	678 7.9 L	682 3.1 Dr	073508
699 10.7 An	685 9.8 Ah	V AUR	685 7.8 L	684 3.2 Dr	668[12.3 Ch
699 10.5 Be	685 10.0 Ch	061647	R LYN	684 3.1 Dw	678 13.3 L
702 11.1 L	687 9.4 B	679 11.2 L	065355	686 3.4 Dw	681[11.3 An
705 10.6 Pt	688 10.1 Ch	680 11.0 B	673[12.4 Ch	691 3.7 Dr	684 13.4 Dr
707 10.0 B	705 10.0 B	698 10.4 B	678 13.3 L	RR MON	685 13.9 B
708 9.9 Pt	V CAM	702 11.0 Lg	687[13.0 B	071201	696[11.9 Ty
709 10.0 Sf	054974	702 10.9 L	V CMI	673 11.1 Ch	699 13.1 L
S COL	674 12 6 Ch	V MON	070109	678 11.3 L	699 13.6 B
054331	685 12.7 L	*061702*	678 14.4 L	683 11.2 Br	S GEM
620 10.4 Bl	699 12.8 Pt	684 12.1 Pt	683[13.5 Br	685 11.2 L	073723
626 10.5 Bl	699 13.3 B	AG AUR	704[13.0 Wn	685 11.2 Ch	671 11.7 Ch
634 10.5 Bl	708 12.8 Wn	062047	708[13.4 Lg	690 10.4 Lg	684 9.8 Br
645 11.4 Sm	Z AUR	678 8.9 L	R GEM	702 10.4 Lg	687 9.6 B
647 11.3 Bl	055353	685 9.2 L	070122a	705 11.2 Sf	698 9.0 Pt
649 11.6 En	680 9.6 B	702 10.0 L	672 8 6 Ah	V GEM	702 9.0 Lg
650 11.4 Ht	685 9.4 B	U LYN	673 8.7 Ah	071713	W PUP
656 11.7 Bl	689 9.6 Pt	063159	673 9.3 Ch	672 10.9 Ah	*074241*
658 11.6 Sm	697 10.3 Pt	680 13.8 B	683 9.4 Br	673 11.0 Ch	620 12.4 Bl
659 11.7 En	698 10.0 Pt	699 14.0 B	685 9.5 Ah	678 11.3 L	626 12.9 Bl
661 11.5 Ht	698 10.0 B	R MON	685 9.5 Ch	683 11.5 Br	634 12.6 Bl
663 11.6 Bl	699 9.9 Pt	063308	687 9.1 B	687 11.5 B	647 11.6 Bl
670 11.9 Ht	701 10.0 Pt	684 11.6 Pt	687 9.7 Ah	698 11.5 Pt	647 11.2 En
Z TAU	705 10.4 Pt	701 11.7 B	698 10.0 Pt	S CMI	650 10.8 Ht
054615a	708 10.6 Pt	702 11.3 Lg	704 10.3 Wd	072708	653 11.4 Sm
667 10.4 Nz	R OCT	711 11.1 Lg	704 9.3 Jo	674 10.8 Ch	654 10.4 En
671 10.1 Nz	*055686*	NOV PIC	712 9.8 Jo	691 11.2 BL	656 10.0 Bl
672 10.4 Ch	614 12.1 Bl	*063462*	Z GEM	697 11.4 BL	658 9.9 Sm
698 11.5 Sf	626 12.4 Bl	644 7.7 En	070122b	698 11.6 Pt	661 9.5 Ht
709 11.6 Sf	647 12.1 Bl	649 7.8 En	698 12.4 Pt	699 11.6 BL	663 9.4 Bl
RU TAU	650 12.0 Ht	650 7.4 Ht	TW GEM	702 11.4 Lg	670 9.1 Ht
054615c	656 11.9 Bl	654 7.8 En	070122c	706 11.9 B	T GEM
671[14.7 Nz	663 11.8 Bl	658 7.3 Sm	698 8.0 Pt	T CMI	074323
R COL	670 11.8 Ht	661 7.5 Sm	R CMI	072811	671 9.0 Ch
054629	671 11.8 Dr	661 7.6 Ht	070310	699 14.0 B	684 9.1 Br
620 9.8 Bl	680 11.6 Dr	670 7.5 Ht	672 10.8 Ah	Z PUP	687 9.1 B
626 9.5 Bl	686 11.5 Dw	S LYN	678 11.0 L	*073820b*	698 9.1 Pt
634 9.6 Bl	X AUR	063558	685 11.0 L	645 14.2 Nz	U PUP
645 9.6 Sm	060450	673 10.7 Ch	687 10.8 Ah	648 14.2 Nz	*075612*
647 10.4 Bl	671 11.2 Ch	685 10.6 B	704 10.6 Wn	660 14.2 Nz	671 13.2 Ch
649 10.3 En	673 11.3 Lj	698 11.0 Sf	706 10.0 B	670[12.1 Nz	684[11.8 Ty
656 10.3 Bl	674 10.8 Ch	699 11.2 Pt	708 10.0 Lg	671 14.1 Nz	691[11.1 Ty
658 10.2 Sm	679 11.0 Lj	706 11.0 B	R VOL	S VOL	696[11.5 Ty
659 10.5 En	680 10.6 Lj	709 11.6 Sf	*070772*	*073173*	698[12.2 Ty
669 10.7 Dr	680 10.5 B	X GEM	646 13.4 En	614[13.2 Bl	711[12.2 Ty
673 10.8 Dr	680 10.4 Ch	064030	670[13.4 Ht	646 12.2 En	712[12.2 Ty
680 10.8 Dr	684 10.3 Lj	685 13.6 B	671 13.6 Dr	647 12.2 Bl	R CNC
684 10.9 Dr	685 10.3 Ch	706 13.5 B	674 13.6 Dr	650 12.2 Ht	081112
686 11.5 Dw	686 10.2 Ch		687 13.8 Dr	654 12.2 En	672 9.7 Ah
	686 10.3 Lj		687 13.5 Dw	654 11.8 Sm	673 9.6 Ah
	688 10.0 Ch			656 11.7 Bl	675 9.4 Ch

Variable Star Observations Received During April, 1929.

J.D.Est.Obs. J.D.Est.Obs. J.D.Est.Obs. J.D.Est.Obs. J.D.Est.Obs. J.D.Est.Obs.

R Cnc
081112
685 8.7 Ah
687 8.7 Ch
687 8.7 Ah
688 8.7 Ah
689 8.5 Ah
693 8.3 Ah
698 8.2 Pt
704 8.0 Wd
706 7.1 B

V Cnc
081617
676 12.5 Ch
684 12.5 Br
698 12.0 Pt
698 12.4 Ty
707 11.7 B
712 11.5 Ty

RT Hya
082405
698 7.7 Pt

R Cha
082476
626 8.9 Bl
634 8.6 Bl
647 8.1 Bl
649 8.3 En
653 8.4 Sm
656 8.5 Bl
658 8.6 Sm
663 8.2 Bl

U Cnc
083019
668 11.4 Ch
678 10.0 L
687 9.6 Ch
690 9.1 L
702 9.1 Lg
704 9.1 Sf
704 9.4 Am
707 9.4 B
708 9.4 Wn

X UMa
083350
680 13.8 B

S Hya
084803
673 10.9 Ch
685 9.0 Ah
686 10.4 Ch
687 9.2 Ah
688 9.0 Ah
698 9.8 Pt
702 10.2 Lg
707 9.3 B

T Hya
085008
673 12.4 Ch
678 12.4 L

T Hya
085008
699 11.8 L
699 11.7 An
702 11.2 Lg
707 11.1 B

T Cnc
085120
680 8.9 Wy
698 8.1 Pt

T Pyx
090031
647 [w Bl

V UMa
090151
679 10.4 L
690 10.7 L
691 10.7 Be
691 10.6 An

W Cnc
090425
671 13.1 Ch
678 12.6 L
688 12.6 Sf
698 12.3 An
699 11.7 L
704 12.0 Sf
704 12.0 Am
708 11.6 Wn

RX UMa
090567
679 11.1 L
692 10.9 L

RW Car
091868
614[12.8 Bl
647[13.5 Bl
674 14.8 Dr
687 14.9 Dr
687 15.1 Dw

Y Vel
092551
614 13.5 Bl
626 13.4 Bl
634[12.9 Bl
644 12.4 En
647 13.4 B
650 12.4 En
650 12.9 Ht
653[12.9 Sm
656 13.3 Bl
674 14.1 Dr
687 14.1 Dr
687 13.7 Dw

R Car
092962
645 4.1 Sm
650 4.7 En
650 4.3 Ht
654 4.2 Sm
656 4.4 Bl
661 4.3 Sm
663 4.6 Bl
669 4.7 Dr
670 4.9 Ht
671 4.8 Dr
673 4.9 Dr
680 5.1 Dr
684 5.3 Dr
684 5.4 Dw
686 5.4 Dw
691 5.7 Dr

X Hya
093014
658 12.3 Nz
660 12.1 Nz
664 11.6 Nz
680 11.1 Wy
698 9.8 Pt
702 9.5 Lg
707 9.5 B

Y Dra
093178
676 11.6 Ch
679 11.4 L
692 12.0 L

R LMi
093934
672 10.6 Ah
673 10.6 Ah
687 9.9 Ah
687 9.6 B
688 9.8 Ah
698 8.9 Pt

RR Hya
094023
681 14.2 Dr

R Leo
094211
672 10.2 Ah
673 10.2 Ah
676 10.6 Ch
685 10.3 Ah
686 10.3 An
686 10.2 Be
687 10.3 Ah
688 10.3 Ah
689 10.5 Ch
691 10.2 BL
694 10.0 BL
697 10.1 BL
698 10.4 An
698 10.0 Pt
699 10.2 BL

R Leo
094211
704 10.0 BL
704 10.1 Wd
704 10.1 Jo
706 10.2 BL
708 10.2 BL
709 10.2 BL
712 9.8 Jo
714 10.1 BL
719 9.6 BL

L Car
094262
686 4.0 Dw

Y Hya
094622
698 6.3 Pt

Z Vel
094953
614 13.6 Bl
644 12.3 En
647[13.5 Bl
650[12.1 En
653[12.1 Sm
658[12.8 Sm
661[12.8 Ht
670[12.8 Ht
674 14.8 Dr

V Leo
095421
686 13.0 Ch
688 13.0 Sf
698 12.7 Pt
704 12.6 Sf
704 12.7 Am
708 12.0 Wn

RV Car
095563
614[13.1 Bl
644[12.5 En
647[14.0 Bl
650[12.5 En
674 12.8 Dr
684 12.0 Dr

RY Leo
095814
684 8.7 Kl
686 8.8 Kl
698 8.8 Kl
699 8.8 Kl
707 8.9 Kl
709 8.9 Kl
712 8.9 Kl
713 8.9 Kl

S Car
100661
626 7.2 Bl
634 6.9 Bl
644 6.5 En
645 6.5 Sm

S Car
100661
647 6.4 Bl
650 6.4 En
650 6.0 Ht
653 6.2 Sm
656 6.3 Bl
661 6.0 Ht
661 6.2 Sm
663 6.2 Bl
669 5.8 Dr
670 6.0 Ht
671 5.9 Dr
674 5.9 Dr
678 6.0 Dr
684 6.7 Dr
684 6.4 Dr
686 6.6 Dw
691 6.4 Dr

Z Car
101058a
626 11.5 Bl
634 12.0 Bl
644 11.6 En
647 12.5 Bl
653 12.1 Sm
656 12.4 Bl
658 12.5 Sm
674 13.0 Dr

AF Car
101058b
674[14.5 Dr

W Vel
101153
626 10.9 Bl
634 9.8 Bl
647 9.0 Bl
649 9.3 En
656 9.1 Bl
658 9.3 Sm
663 8.8 Bl
670 8.9 Ht

U Hya
103212
678 4.7 L
691 4.8 L

RZ Car
103270
669 8.8 Dr
671 9.0 Dr
673 9.1 Dr
680 9.7 Dr
684 9.9 Dr
684 9.7 Dw

R UMa
103769
672 7.6 Ah
673 7.9 Ah
678 7.9 Ch
681 7.7 Ah

R UMa
103709
685 8.0 Ah
687 8.2 Ah
688 8.4 Ah
689 8.4 Ah
689 8.1 Ch
690 8.4 Ah
692 8.5 Ah
693 8.4 Ah
696 8.6 B
698 8.8 Wd
698 8.5 Pt
704 8.8 Wd
704 8.4 Jo
708 8.9 B
712 8.8 Jo

V Hya
104620
626 7.5 Bl
634 7.5 Bl
647 7.4 Bl
656 7.5 Bl
663 7.2 Bl
679 7.4 L
691 7.2 L
698 6.7 Pt

RS Hya
104628
614[12.0 Bl
647 12.0 Bl
656 11.7 Bl
663 11.4 Bl

W Leo
104814
658 13.6 Nz
664[12.7 Nz
673[13.4 Ch
708 12.9 Wn

RS Car
110361
649[12.3 En
653[12.3 Sm

S Leo
110506
673[13.1 Ch
686 13.4 Ch

RY Car
111561
614[13.5 Bl
626[13.5 Bl
647[13.5 Bl
656[13.5 Bl
684 14.0 Dw

RS Cen
111661
614 13.5 Bl
626 12.9 Bl
646 12.1 En
647 12.2 Bl

VARIABLE STAR OBSERVATIONS RECEIVED DURING APRIL, 1929.

J.D.Est.Obs.	J.D.Est.Obs.	J.D.Est.Obs.	J.D.Est.Obs.	J.D.Est.Obs.	J.D.Est.Obs.
RS CEN	T VIR	T UMA	S UMA	RV CEN	T APS
111661	*120905*	123160	123961	*133155*	*134677*
653 11.6 Sm	674 9.5 Ch	698 10.0 Wd	704 9.8 Jo	626 9.0 Bl	614 12.9 Bl
654 11.6 En	679 9.4 L	698 10.3 Kl	712 10.0 Jo	634 8.7 Bl	626 12.2 Bl
656 11.0 Bl	688 9.4 Sf	698 9.7 Pt	RU VIR	647 8.9 Bl	634 11.8 Bl
658 11.4 Sm	690 9.6 L	701 10.1 B	124204	656 8.7 Bl	647 10.9 Bl
663 9.9 Bl	698 9.5 Pt	704 10.4 Jo	679 11.8 L	663 8.5 Bl	649 10.8 En
671 9.3 Dr	701 10.0 B	704 10.4 Wd	690 11.9 L	673 8.0 Dr	650 10.4 Ht
674 9.1 Dr	704 10.6 Am	R VIR	698 12.0 Pt	T UMI	654 10.0 Sm
680 9.0 Dr	704 10.3 Sf	123307	708 11.9 B	133273	654 10.0 En
684 8.8 Dr	708 10.1 Wn	672 8.2 Ah	U VIR	679 14.5 L	656 10.0 Bl
684 9.1 Dw	R CRV	673 8.1 Ah	124606	708 13.1 Wn	661 9.8 Sm
691 8.7 Dr	*121418*	678 7.5 Ch	675 10.8 Ch	709 13.1 Sf	670 9.5 Ht
X CEN	658 8.0 Nz	687 7.6 Ah	678 10.3 L	T CEN	671 9.0 Dr
114441	664 7.8 Nz	688 7.3 Ah	686 9.8 Ch	*133633*	680 9.7 Dr
626 7.0 Bl	679 8.6 L	689 7.4 Ah	687 9.7 Ah	629 6.7 Bl	684 9.6 Dr
634 7.3 Bl	690 8.7 L	690 7.3 Ah	688 9.7 Ah	647 7.8 Bl	691 9.2 Dr
647 7.9 Bl	698 9.1 Pt	692 7.1 Ah	690 9.4 Ah	650 8.1 Ht	RR VIR
656 8.1 Bl	708 9.3 B	693 6.9 Ah	690 9.6 L	651 8.2 En	*135908*
663 8.5 Bl	SS VIR	698 6.1 Pt	698 8.7 Pt	656 7.1 Bl	701 13.1 Pt
673 8.6 Dr	*122001*	708 7.3 B	701 9.0 B	658 7.4 Sm	709 13.0 Wn
684 9.5 Dr	679 9.0 L	713 7.0 Rw	RV VIR	661 6.7 Ht	Z BOO
686 9.2 Dw	690 8.6 L	RS UMA	*130212*	663 6.3 Bl	140113
AD CEN	708 9.1 B	123459	675 10.8 Ch	670 6.2 Ht	678 11.7 L
114858	T CVN	658 14.1 Nz	678 11.1 L	671 6.0 Dr	690 12.7 L
650 9.1 Ht	122532	664 14.3 Nz	689 10.7 Ch	674 6.0 Dr	708 12.9 Wn
654 9.0 Sm	678 9.7 Ch	698 13.8 Pt	690 10.9 L	680 6.0 Dr	Z VIR
661 9.0 Sm	698 9.5 Pt	704 10.6 Wd	708 11.5 Wn	684 6.1 Dr	*140512*
661 9.5 Ht	708 10.3 B	S UMA	U OCT	691 6.1 Dr	678 11.2 L
670 9.4 Ht	709 10.1 BL	123961	*131283*	RT CEN	687 10.8 Ch
W CEN	714 10.2 BL	672 8.4 Ah	626 12.7 Bl	*134236*	690 11.3 L
115058	719 10.3 BL	673 8.6 Ah	647 13.8 Bl	629 11.6 Bl	RU HYA
614 10.8 Bl	T VIR	673 8.9 Lj	653 13.2 Sm	647 11.0 Bl	*140528*
626 9.1 Bl	*122803*	676 8.9 Lj	670 13.2 Ht	650 10.4 Ht	629 10.7 Bl
634 8.0 Bl	658 11.9 Nz	679 9.0 Lj	681 14.1 Dr	651 10.9 En	647 11.6 Bl
645 8.4 Sm	664 11.6 Nz	681 8.7 Ah	V VIR	656 10.2 Bl	650 11.7 Ht
647 8.1 Bl	679 10.5 L	684 9.1 Lj	*132202*	658 9.9 Sm	652 12.2 En
649 8.2 En	690 9.8 L	684 9.1 Kl	675 11.7 Ch	661 10.1 Ht	656 12.2 Bl
650 8.2 Ht	701 9.5 B	685 9.0 Ah	679 12.1 L	663 9.4 Bl	680 12.8 Dr
654 8.0 Sm	U CEN	686 9.3 Kl	690 10.4 L	671 9.5 Dr	R CEN
656 8.1 Bl	*122854*	686 9.0 Ch	R HYA	680 9.4 Dr	*140959*
661 8.3 Ht	626 8.9 Bl	686 9.1 Lj	*132422*	684 9.2 Dr	626 7.9 Bl
661 8.2 Sm	634 8.6 Bl	686 9.2 An	629 6.7 Bl	691 9.4 Dr	634 7.1 Bl
663 8.1 Bl	647 8.5 Bl	686 9.4 Be	647 7.2 Bl	R CVN	645 6.5 Sm
670 8.4 Ht	656 8.7 Bl	687 9.3 Ah	651 7.6 En	134440	647 6.8 Bl
R COM	663 8.8 Bl	688 9.4 Ah	656 7.4 Ah	672 9.8 Ah	661 5.9 Sm
115919	T UMA	689 9.4 Ah	658 7.6 Sm	673 10.0 Ah	661 6.0 Ht
680 11.1 Wy	123160	689 9.2 Lj	661 7.8 Ht	678 10.1 Ch	663 6.2 Bl
698 8.5 Pt	672 8.6 Ah	690 9.6 Ah	663 7.6 Bl	687 9.8 Ah	669 6.0 Dr
708 7.7 BL	673 8.6 Ah	691 9.2 Lj	678 8.1 L	688 9.4 Ah	670 6.0 Ht
708 8.1 B	681 9.1 Ah	692 9.5 Ah	684 8.7 Ch	690 9.6 Ah	671 5.8 Dr
714 7.7 BL	684 9.1 Kl	693 9.4 Ah	690 8.2 L	701 8.6 Pt	674 5.9 Dr
719 7.7 BL	685 9.6 Ah	697 9.5 Lj	701 8.5 Pt	708 9.3 B	678 5.8 Dr
SU VIR	686 9.0 Kl	698 9.2 Wd	S VIR	RX CEN	680 5.7 Dr
120012	686 9.3 Ch	698 9.5 Pt	*132706*	*134536*	684 6.0 Dr
680 12.3 Wy	687 9.6 Ah	698 9.5 Kl	684 11.5 Ch	647 10.0 Bl	684 6.0 Dw
698 12.6 Pt	688 9.7 Ah	698 9.7 An	701 10.2 Pt	656 9.0 Bl	U UMI
701 12.8 B	689 9.7 Ah	700 9.5 Lj	708 9.8 B	663 9.1 Bl	141567
	690 9.8 Ah	701 9.9 B			676 11.9 Lj
	692 10.0 Ah	704 10.0 Wd			679 12.0 Lj

VARIABLE STAR OBSERVATIONS RECEIVED DURING APRIL, 1929.

J.D.Est.Obs.	J.D.Est.Obs.	J.D.Est.Obs.	J.D.Est.Obs.	J.D.Est.Obs.	J.D.Est.Obs.
U UMi	S Aps	X Lib	R CrB	Z CrB	S Sco
141567	*145971*	*153020*	154428	155229	*161122b*
684 11.7 Lj	626[13.4 Bl	649 10.8 Bl	684 6.0 L	679 12.0 L	658 12.1 Nz
687 11.5 Lj	629[14.0 Bl	W Lib	685 6.1 Ch	687 11.4 Ch	664 12.4 Nz
689 11.2 Lj	634[12.5 Bl	*153215*	687 6.1 Lj	691 11.7 L	689 13.1 Pt
697 10.9 Lj	647[14.0 Bl	629[12.5 Bl	687 5.9 Ah	708 11.5 Wn	W CrB
700 10.9 Lj	650[11.9 En	649[13.4 Bl	688 6.1 Ah	RZ Sco	161138
701 11.0 Pt	656 14.0 Bl	678 13.0 L	688 6.2 Lj	*155823*	689 12.5 Pt
S Boo	661[12.5 Sm	680 12.8 Dr	688 6.1 Pt	650 9.1 Ht	W Oph
141954	663[13.4 Bl	684 12.3 Dr	689 6.2 Pt	708 9.9 Pt	*161607*
679 9.9 L	RT Lib	687 10.2 Ch	690 6.1 Ah	Z Sco	679 13.9 L
692 9.6 L	*150018*	690 12.1 L	690 6.1 Ch	*160021*	691 13.9 L
701 8.9 Pt	701 12.0 Pt	S UMi	690 6.0 L	629 11.1 Bl	V Oph
712 8.5 Jo	709[12.0 Wn	153378	691 6.0 L	649 11.4 Bl	162112
RS Vir	T Lib	672 10.6 Ah	691 6.1 Pt	650 11.5 Ht	678 7.6 L
142205	*150519*	673 10.4 Lj	692 6.0 Ah	678 12.1 L	689 7.3 Pt
658 11.2 Nz	678 13.3 L	676 10.5 Lj	692 6.0 L	691 12.1 L	691 7.5 L
664 10.7 Nz	690 13.8 L	679 10.5 Lj	693 6.1 Ah	R Her	U Her
678 11.6 L	709[12.0 Wn	684 10.8 Lj	697 6.2 Lj	160118	162119
690 12.1 L	Y Lib	687 11.0 Lj	698 5.8 Wd	701 9.0 Pt	689 11.2 Pt
V Boo	*150605*	687 11.0 Lj	698 6.0 L	U Ser	Y Sco
142539a	678 13.6 L	697 11.2 Lj	699 6.2 Pt	160210	*162319*
672 8.8 Ah	690[13.4 L	700 11.4 Lj	701 6.1 Pt	701 10.0 Pt	679 13.6 L
673 8.7 Ah	S Lib	701 10.8 Pt	701 6.2 Lj	X Sco	691 13.4 L
687 8.4 Ah	*151520*	U Lib	704 6.1 Pt	*160221a*	SS Her
688 8.3 Ah	678 9.3 L	*153620a*	704 6.0 Gb	629[12.8 Bl	162807
689 8.3 Ah	690 8.3 L	629[12.9 Bl	706 6.2 Pt	649 13.0 Bl	679 9.5 L
690 8.3 Ah	701 8.2 Pt	649[13.1 Bl	706 6.0 Wd	SX Her	689 10.0 Pt
692 8.0 Ah	S Ser	680 11.4 Dr	707 6.2 Pt	160325	691 9.6 L
693 8.1 Ah	151714	684 11.4 Dr	708 6.2 Pt	679 7.8 L	T Oph
701 8.2 Pt	678 13.5 L	T Nor	708 5.9 Wd	688 7.9 Pt	*162815*
712 8.0 Jo	690 13.6 L	*153654*	709 6.2 Kl	689 7.9 Pt	629[12.0 Bl
R Boo	S CrB	650 8.1 Ht	712 5.9 Jo	691 7.8 L	649[12.8 Bl
143227	151731	661 8.1 Ht	712 6.0 Gy	699 7.9 Pt	679 11.3 L
672 10.5 Ah	701 10.0 Pt	670 8.1 Ht	713 6.5 Rw	701 7.9 Pt	680 11.3 Dr
673 10.3 Ah	RS Lib	674 7.8 Dr	716 6.1 Sb	706 8.1 Pt	684 11.3 Dr
673 10.7 Lj	*151822*	680 7.9 Dr	718 6.0 Sb	708 8.0 Pt	689 11.1 Pt
676 10.5 Lj	629 8.6 Bl	684 8.0 Dr	X CrB	W Sco	691 10.3 L
679 10.4 Lj	649 9.7 Bl	691 8.4 Dr	154536	*160510*	S Oph
684 9.8 Lj	650 10.0 Ht	Z Lib	679 12.4 L	649 12.8 Bl	*162816*
687 9.8 Lj	678 11.3 L	*154020*	691 12.8 L	680 11.4 Dr	629[11.8 Bl
687 10.0 Ah	690 11.5 L	629 12.4 Bl	R Ser	684 11.5 Dr	649 11.2 Bl
688 9.9 Ah	RU Lib	649 13.0 Bl	154615	RU Her	679 10.3 L
689 10.1 Lj	*152714*	680[13.2 Dr	701 10.1 Pt	160625a	680 10.2 Dr
690 9.8 Ah	678 10.3 L	R CrB	V CrB	679 13.4 L	684 10.4 Dr
697 9.8 Lj	690 9.2 L	154428	154639	680 13.2 Ch	691 10.2 L
701 10.0 Pt	701 9.0 Pt	672 6.2 Lj	701 9.8 Pt	691 13.8 L	W Her
712 8.7 Jo	R Nor	672 6.1 Ah	R Lib	R Sco	163137
713 8.0 Rw	*152840*	673 6.0 Ah	154715	*161122a*	680 11.2 Ch
V Lib	629 12.4 Bl	673 6.2 Lj	678 10.3 L	629 11.9 Bl	687 11.0 Ch
143417	647 12.0 Bl	675 6.0 L	680 9.8 Ch	649 11.2 Bl	689 10.9 Pt
678 9.3 L	650 11.7 Ht	675 6.1 Ch	690 9.9 L	650 10.0 Ht	712 9.6 Jo
690 9.7 L	656 10.7 Bl	676 6.2 Lj	RR Lib	658 10.5 Nz	R Dra
Y Lup	663 9.9 Bl	678 6.1 Lj	*155018*	664 10.4 Nz	163266
145254	674 9.1 Dr	678 6.0 L	678 13.6 L	689 11.6 Pt	676 11.4 Lj
629[13.7 Bl	680 9.1 Dr	679 6.0 L	680 13.6 Dr	S Sco	679 11.4 Lj
647[13.7 Bl	691 8.4 Dr	679 6.2 Lj	684 12.7 Dr	*161122b*	684 11.5 Lj
681 15.2 Dr	X Lib	680 6.1 Lj	691 11.9 L	629 11.3 Bl	687 11.7 Lj
	153020	681 6.1 L	708 11.2 Pt	649 11.7 Bl	689 11.7 Lj
	629 10.5 Bl	684 5.9 L		650 11.3 Ht	689 12.4 Pt

VARIABLE STAR OBSERVATIONS RECEIVED DURING APRIL, 1929.

J.D.Est.Obs.	J.D.Est.Obs.	J.D.Est.Obs.	J.D.Est.Obs.	J.D.Est.Obs.	J.D.Est.Obs.
RR OPH	S OCT	T HER	R SCT	RS LYR	TZ CYG
164319	*172486*	180531	*184205*	190933a	191350
664 9.4 Nz	647 13.5 Bl	672 8.5 Ah	689 5.8 Pt	680[13.1 Ch	706 10.5 Pt
679 10.2 L	649[12.8 En	673 8.5 Ah	690 5.0 L	684[14.0 L	U LYR
689 10.3 Pt	650[15.0 Ht	679 8.1 L	691 5.6 Pt	RU LYR	191637
691 10.5 L	653[12.8 Sm	687 8.2 Ah	697 5.5 Lj	190941	706 9.9 Pt
S HER	656 12.9 Bl	688 8.2 Ah	706 5.9 Pt	680 12.3 L	TY CYG
164715	670 12.8 Ht	689 7.9 Pt	708 5.8 Pt	686 13.0 Ch	192928
689 11.3 Pt	680 11.6 Dr	689 8.1 Ch	NOV AQL	692 12.7 L	680 12.7 Ch
RS SCO	684 11.1 Dr	690 8.3 Ah	184300	U DRA	685 12.5 Ch
164844	RU OPH	691 8.2 L	688 11.6 Pt	190967	685 12.3 L
629 10.7 Bl	172809	693 8.4 Ah	706 11.6 Pt	680 11.9 Ch	RT AQL
649 11.1 Bl	670 9.5 Ch	704 8.8 Gb	RX LYR	680 12.1 L	193311
650 11.5 Ht	679 9.5 L	W DRA	185032	685 12.4 Ch	680 13.0 Ch
680 12.0 Dr	689 9.1 Pt	180565	680 13.9 L	689 12.7 Pt	682 12.6 L
RR SCO	691 9.5 L	679 13.2 L	689 13.1 Pt	692 12.6 L	R CYG
165030a	RT SER	X DRA	690 13.4 Ch	T SGR	193449
629 6.4 Bl	*173411*	180666	692 13.4 L	*191017*	690 10.6 Ch
649 7.1 Bl	679 12.6 L	679 11.9 L	S CRA	682 11.5 L	706 9.2 Pt
650 7.5 Ht	691 12.3 L	691 12.3 L	*185437a*	684 11.8 Ch	RV AQL
674 8.7 Dr	RU SCO	TV HER	649 11.5 Bl	689 11.7 Pt	193509
680 9.2 Dr	*173543*	181031	R CRA	692 11.5 L	682 13.8 L
684 9.2 Dr	629 11.6 Bl	681[13.3 L	*185537a*	R SGR	686[13.3 Ch
SS OPH	649 12.2 Bl	691[14.0 L	649 11.5 Bl	*191019*	T PAV
165202	SV SCO	RY OPH	T CRA	681 8.0 Ch	*193972*
689 12.7 Pt	*174135*	181103	*185537b*	684 8.0 Ch	614 13.5 Bl
RV HER	629[12.2 Bl	689 11.5 Pt	649[13.0 Bl	689 8.6 Pt	629[13.2 Bl
165631	649[12.8 Bl	W LYR	Z LYR	RY SGR	647[13.2 Bl
678 10.9 Ch	W PAV	181136	185634	*191033*	650[13.2 Ht
679 11.7 L	*174162*	689 12.3 Pt	680 11.7 L	649 6.0 Bl	680 11.7 Dr
689 11.9 Pt	629 11.1 Bl	RV SGR	683 11.8 Ch	678 6.3 L	684 11.6 Dr
691 12.0 L	647 10.3 Bl	*182133*	689 11.8 Pt	680 6.3 Dr	RT CYG
RT SCO	650 10.1 Ht	649 14.0 Bl	692 12.1 L	682 6.2 Dr	194048
165636	656 9.9 Bl	SV HER	RT LYR	682 6.2 Dw	706 9.6 Pt
629[13.0 Bl	RS OPH	182224	185737	684 5.8 L	TU CYG
649[13.0 Bl	174406	681[13.9 L	680[13.0 Ch	684 6.2 Dr	194348
— DRA	689 11.1 Pt	SV DRA	681[13.9 L	685 6.0 L	678 9.5 Ch
165752	RT OPH	183149	690[13.0 Ch	686 6.3 Dw	690 9.6 Ch
679[14.0 L	175111	679[13.9 L	R AQL	688 6.5 Pt	692 9.5 L
691[14.0 L	680 12.1 Ch	RZ HER	190108	689 6.2 Pt	706 10.4 Pt
RT HER	681 12.5 L	183225	689 8.1 Ch	690 5.9 L	X AQL
170627	691 12.3 L	681 13.0 OL	689 7.2 Pt	691 5.9 L	194604
678 11.0 Ch	RY HER	X OPH	V LYR	692 5.9 L	684 13.8 L
678 10.9 L	175519	183308	190529a	706 6.3 Pt	686[13.4 Ch
689 10.7 Pt	678 11.9 Ch	680 8.6 L	683 11.4 Ch	TY SGR	χ CYG
691 9.9 L	681 11.3 L	689 9.0 Pt	692[13.3 L	*191124*	194632
RW SCO	684 11.3 Ch	692 8.6 L	RX SGR	649 11.7 Bl	680 10.9 Ch
170833	689 11.0 Pt	RV LYR	*190818*	680 12.8 Dr	685 10.5 Ch
629[12.5 Bl	691 10.7 L	184134	689 9.0 Pt	S SGR	686 10.5 Ch
649[12.6 Bl	V DRA	684 13.7 L	TY AQL	*191319a*	688 10.2 Ah
Z OPH	175654	R SCT	190907	684 11.8 L	690 10.5 Ch
171401	680[13.1 Ch	*184205*	689 10.1 Pt	689 11.9 Pt	706 9.0 Pt
689 11.7 Pt	R PAV	672 5.6 Lj	S LYR	— SGR	S PAV
RS HER	*180363*	678 5.2 L	190925	*191319b*	*194659*
171723	650 8.5 Ht	679 5.4 Lj	680[12.9 Ch	689 11.5 Pt	680 7.5 Dr
689 12.1 Pt	674 7.5 Dr	680 5.6 Lj	X LYR	SW SGR	684 7.4 Dr
S OCT	680 7.4 Dr	683 5.6 Ch	190926	*191331*	RR SGR
172486	684 7.7 Dr	684 5.0 L	689 8.9 Pt	649 11.4 Bl	*194929*
614[13.0 Bl		687 5.6 Lj			680 10.2 Dr
629[13.0 Bl		688 5.5 Pt			684 9.6 Dr

Variable Star Observations Received During April, 1929.

J.D.Est.Obs.

RU Sgr
195142
649 10.8 Bl
RR Aql
195202
684 12.8 L
690[13.1 Ch
RS Aql
195308
684 13.2 L
690 12.9 Ch
Nov Cyg
195553
685 13.5 Ch
688[12.2 Pt
689[12.2 Pt
706[12.2 Pt
708[12.2 Pt
Z Cyg
195849
685 13.2 Ch
706 12.6 Pt
S Tel
195855
614[12.6 Bl
649[13.0 Bl
SY Aql
200212
684 12.1 Ch
684 12.4 L
BU Cyg
200250
676 11.1 Lj
680 11.3 Lj
689 11.6 Lj
689 11.7 Lj
S Cyg
200357
685 10.6 Ch
686 10.5 L
706 10.8 Pt
S Aql
200715a
706 9.6 Pt
RW Aql
200715b
706 9.4 Pt
R Tel
200747
649 12.0 Bl

J.D.Est.Obs.

RU Aql
200812
680 11.0 L
684 10.6 Ch
692 10.1 L
Z Aql
200906
706 12.6 Pt
RS Cyg
200938
684 6.8 L
706 7.5 Pt
R Del
201008
684 12.4 L
706 12.6 Pt
SX Cyg
201130
684 12.2 L
685 12.2 Ch
706 12.8 Pt
RT Sgr
201139
680 11.3 Dr
684 11.1 Dr
WX Cyg
201437b
684 10.0 L
706 8.9 Pt
U Cyg
201647
706 9.0 Pt
U Mic
202240
614[11.9 Bl
680[13.0 Dr
Z Del
202817
685 12.7 L
ST Cyg
202954
684 12.9 L
685 13.4 Ch
706 12.3 Pt
V Vul
203226
706 8.6 Pt

J.D.Est.Obs.

Y Del
203611
685 13.3 L
690[12.5 Ch
S Del
203816
672 10.1 Lj
680 10.3 Lj
687 10.5 Lj
689 10.5 Lj
697 10.5 Lj
706 10.5 Pt
V Cyg
203847
684 12.7 L
685 12.8 Ch
706 12.8 Pt
T Del
204016
684 8.9 L
690 9.2 Ch
706 8.5 Pt
V Aqr
204102
685 8.2 L
706 8.6 Pt
W Aqr
204104
685 12.1 L
U Cap
204215
692[11.5 L
V Del
204318
685 13.2 L
RZ Cyg
204846
706 10.9 Pt
S Ind
204954
614[13.5 Bl
649[13.1 Bl
680[13.5 Dr
X Del
205017
685[13.2 L
RR Cap
205627
684[13.4 Dr

J.D.Est.Obs.

R Vul
205923a
706 11.8 Pt
TW Cyg
210129
684[13.9 L
X Cep
210382
677 11.5 L
692 12.2 L
RS Aqr
210504
692 11.6 L
R Equ
210812
685 13.0 L
706 11.6 Pt
T Cep
210868
672 9.2 Ah
673 9.3 Ah
687 9.4 Ah
688 9.6 Ah
689 9.6 Ch
706 9.6 Pt
X Peg
211614
706 10.4 Pt
S Mic
212030
620 10.8 Bl
626 10.5 Bl
W Cyg
213244
675 6.4 L
684 6.1 L
690 6.0 L
S Cep
213678
672 10.0 Ah
673 10.0 Ah
687 9.6 Ah
688 9.9 Ah
706 8.5 Pt
RU Cyg
213753
673 9.4 Ah
687 9.6 Ah
688 9.4 Ah
706 8.6 Pt

J.D.Est.Obs.

RV Cyg
213937
675 7.1 L
684 6.8 L
706 6.5 Pt
RR Peg
214024
706 12.7 Pt
R Gru
214247
614[12.9 Bl
626[12.9 Bl
634[12.4 Bl
644[12.4 Bl
RZ Peg
220133b
706 11.8 Pt
T Peg
220412
685 10.2 L
RS Peg
220714
708 11.8 Pt
RV Peg
222129
685 11.7 L
S Lac
222439
685 11.5 L
708 12.9 Pt
R Ind
222867
620 10.6 Bl
626 11.4 Bl
634 12.3 Bl
645 13.0 Bl
671 13.5 Dr
684[13.8 Dr
T Tuc
223462
649 8.0 En
684 8.0 Dr
R Lac
223841
685 11.3 L
708 12.8 Pt
V Cas
230759
708 12.4 Pt

J.D.Est.Obs.

V Phe
232746
645 9.5 Sm
649 9.6 En
654 9.5 Sm
Z And
232848
708 9.5 Pt
ST And
233335
708 10.0 Pt
R Aqr
233815
620 9.0 Bl
626 9.1 Bl
634 8.9 Bl
646 8.8 Bl
655 8.7 Bl
R Phe
235150
671 12.5 Dr
V Cet
235209
614[12.8 Bl
R Tuc
235265
645[13.0 Sm
647[12.9 En
654[12.9 Sm
661[12.4 Sm
R Cas
235350
672 9.4 Ah
673 9.7 Ch
673 9.5 Ah
685 9.7 Ah
687 9.7 Ah
Z Peg
235525
685 10.9 L
678 11.8 L
Y Cas
235855
673 11.8 Ch
678 12.1 L
692 12.1 L

Rapidly Varying Irregular Variables.

Star	J.D.	Est.	Obs.	J.D.	Est.	Obs.
005840 RX Andromedae—						
	5699.	11.5	Pt			
010884 RU Cephei—						
	5678.3	8.7	L	5690.6	8.8	L
060547 SS Aurigae—						
	5645.2	14.3	Nz	5648.1	14.8	Nz
060547 SS Aurigae—						
	5660.2	[15.3	Nz	5671.1	11.4	Nz
	5667.2	11.1	Nz	5671.2	11.6	Ch
	5668.1	11.2	Nz	5672.4	13.0	L
	5670.1	10.8	Nz	5673.2	12.8	Ch
	5670.1	11.4	Nz	5674.2	13.5	Ch

VARIABLE STAR OBSERVATIONS RECEIVED DURING APRIL, 1929.

Star	J.D.	Est.	Obs.	J.D.	Est.	Obs.
060547 SS AURIGAE—						
	5676.1	13.8	Ch	5690.1	12.5	Ch
	5677.3	14.3	L	5691.3	13.3	L
	5678.3	14.3	L	5692.3	13.3	L
	5679.3	14.2	L	5697.7	12.6	Pt
	5680.2	13.9	Ch	5698.6	13.7	B
	5681.4	13.9	L	5699.4	14.5	L
	5682.7	13.8	Br	5701.7	12.6	Pt
	5684.4	15.0	L	5702.3	14.5	L
	5685.3	14.8	L	5705.7	12.4	Pt
	5686.2	13.7	Ch	5707.6	13.7	B
	5687.6	13.0	B	5708.8	12.2	Lg
	5688.1	12.5	Ch	5709.7	12.6	Kz
	5689.7	12.4	Pt	5711.8	13.5	Lg
074922 U GEMINORUM—						
	5645.2	13.7	Nz	5685.6	13.9	B
	5648.2	13.5	Nz	5688.2	12.4	Ch
	5660.2	14.0	Nz	5689.7	11.2	Pt
	5667.2	13.7	Nz	5690.1	10.8	Ch
	5670.1	13.6	Nz	5691.3	10.9	L
	5671.0	14.0	Ch	5692.3	12.4	L
	5671.2	13.6	Nz	5697.7	12.3	Pt
	5672.4	13.3	L	5698.7	13.3	Pt
	5675.2	13.7	L	5699.4	14.0	L
	5676.2	13.7	Ch	5699.4	13.7	An
	5677.3	13.9	L	5701.7	12.4	Pt
	5678.4	14.0	L	5702.3	13.9	L
	5679.3	13.8	L	5702.8	13.7	Lg
	5681.3	13.7	L	5705.7	12.4	Pt
	5682.7	13.9	Br	5706.6	14.0	B
	5684.4	14.0	L	5707.6	13.7	B
	5684.7	13.7	Br	5708.7	12.4	Pt
	5685.2	14.0	Ch	5708.8	13.6	Lg
	5685.3	13.7	L	5711.1	13.4	Lg
081473 Z CAMELOPARDALIS—						
	5675.6	11.4	L	5678.3	11.8	L
	5677.3	11.8	L	5679.3	11.6	L
081473 Z CAMELOPARDALIS—						
	5679.6	11.2	L	5691.6	11.2	L
	5681.4	11.7	L	5692.3	11.5	L
	5682.6	11.3	L	5692.6	11.5	L
	5684.4	11.8	L	5699.4	11.7	L
	5684.6	11.7	L	5698.4	12.7	An
	5685.4	11.8	L	5699.4	11.8	An
	5690.6	11.2	L	5699.4	11.6	Be
	5691.3	11.5	L	5702.3	11.2	L
094512 X LEONIS—						
	5672.3	13.0	L	5685.6	12.8	L
	5678.4	14.0	L	5690.3	12.3	L
	5679.3	14.2	L	5690.6	12.5	L
	5679.6	14.7	L	5691.4	13.0	L
	5681.3	13.9	L	5691.6	12.3	L
	5684.4	14.7	L	5692.4	12.5	L
	5684.6	13.9	L	5699.4	14.7	L
	5685.4	14.7	L			
202946 SZ CYGNI—						
	5688.9	8.9	Pt	5706.9	9.0	Pt
	5689.9	8.9	Pt	5708.9	9.0	Pt
213843 SS CYGNI—						
	5672.7	11.9	Lj	5687.6	11.9	Lj
	5675.7	11.9	L	5688.6	11.9	Lj
	5676.7	11.9	Lj	5688.6	11.6	Ah
	5678.6	11.9	Lj	5688.7	11.9	Lj
	5678.7	12.1	L	5688.9	11.7	Pt
	5679.7	12.1	L	5689.7	11.9	Lj
	5680.5	11.7	Ch	5689.9	11.7	Pt
	5680.6	11.9	Lj	5690.5	11.9	Ch
	5680.7	11.9	L	5690.7	11.5	L
	5682.7	11.7	L	5691.7	11.6	L
	5684.7	11.6	L	5692.6	11.9	L
	5685.5	11.9	Ch	5706.9	11.6	Pt
	5685.7	11.9	L	5708.9	11.6	Pt
	5686.5	11.9	Ch			

SUMMARY OF OBSERVATIONS, APRIL, 1929.

Observer	Initial	Vars.	Observations	Observer	Initial	Vars.	Observations
Ahnert	Ah	34	148	Kohl	Kl	6	19
Ancarani	An	15	23	Kurtz	Kz	4	4
Anderson	Am	5	5	Lacchini	L	158	360
Baldwin	Bl	86	294	Leiner	Lj	12	76
Benini	Be	10	16	Logan	Lg	21	52
Boutell	BL	5	21	Nizamiah Ob.	Nz	23	56
Bouton	B	69	90	Peltier	Pt	156	220
Brocchi	Br	10	16	Rowley	Rw	3	3
Chandra	Ch	119	165	Smith, F. W.	Sf	14	24
Dartayet	Dr	64	166	Smith, W. H.	Sm	38	66
Dawson	Dw	29	35	Soberanes	Sb	1	2
Ensor	En	40	57	Taylor	Ty	7	23
Gaebler	Gb	2	2	Webb	Wd	7	12
Gregory	Gy	2	2	Whitney	Wy	7	7
Houghton	Ht	45	97	Wilson	Wn	17	17
Jones	Jo	10	14				
				Totals		30	398	2089

prevented from doing any observing on account of his professional duties at Scenic, as engineer on the great tunnel recently completed in that place. We also welcome to our columns reports from Miss Mary Anderson of Swarthmore College, and a new member from Santa Ana, California, Mr. Philip Taylor. Both have sent in commendable reports.

Mr. E. H. Jones, our observer from Somerville, Massachusetts, retires from active business on June 1, after more than fifty years of service with the Edison Electric Illuminating Co., and moves to Goffstown, New Hampshire. There he expects to devote his entire energies to variable star observing, and judging by past experiences, we may expect some splendid reports from his hands. He uses the 4-inch Robinson telescope lent to him some years ago by the Association, and plans to house it in a real observing shelter. Success to Mr. Jones in his remaining years of comparative leisure.

LEON CAMPBELL, Recording Secretary.

May 6, 1929.

METEOR NOTES.

By CHARLES P. OLIVIER.

Meteors have been observed by several of our members in the past two months, and the tabular results are given below. Special credit is due B. C. Darling of Lansing, Michigan, for his extensive observations on nights when so few meteors appeared. Few of us have the enthusiasm or patience for these long and poorly repaid watches. However, nine radiants were deduced from his work, which are particularly valuable as we have so few for this period of the year. Another professional astronomer sends in his first results; Professor Martin Dartayet of the La Plata Observatory, Argentine Republic. Besides the two nights recorded below, which refer of course to the usual visual observations, he has sent in a valuable list of 31 telescopic meteors, with all the desirable particulars about each. His instrument, an 8-inch comet-seeker, is a splendid one for this work.

From New Zealand, R. A. McIntosh sends in his usual fine contribution of southern radiants. He thinks that his radiants No. 109 and No. 111 may be connected with one (1877i) given by A. Herschel in his lists for comet-meteor accordances. McIntosh has computed an orbit for the March 13 radiant, and the writer for the March 20 radiant, but it is necessary to go more fully into the matter before giving an opinion, though the case looks promising. In this part of the country our only report is from Vincent Anyzeski of New Haven, Connecticut. His results for three nights in May led to the determination from his maps of seven radiants, of which six seem to be more than usually certain and with small radiant areas. No one has reported anything on the Eta Aquarids so far, but most of the May reports will not be in for some time.

By the first of July at latest we hope to distribute two publications on meteors, besides Bulletin No. 10 of the A.M.S., to our members. To save both time and expense, it is planned to mail all these under one cover. The writer will probably be absent during most of June, so that requisitions for maps, etc., received during that period, will have to await his return before being filled. As POPULAR ASTRONOMY is not issued for two of the summer months, this last chance is taken to urge upon our inactive members the desirability of their making the necessary efforts

to get a start during the summer months, particularly when the great Perseid stream offers such a fine opportunity in August. If each inactive member would only do a little personal observing, the sum total, added to what the others do, would be very large.

TABLE I.

BERT C. DARLING, LANSING, MICH.
(Central Standard Time)

		Began	Ended	Min.	Factor	Meteors	Rate	Cor. Rate
1929 March	14	8:15	11:00	165	0.7	7	2.5	3.6
	16	7:45	12:00	208	0.5	0	0.0	0.0
	17	11:56	13:00	64	1.0	2	1.9	1.9
		16:40	17:56	76	1.0	5	3.9	3.9
	18	11:20	12:13	53	0.9	1	1.1	1.2
	19	9:26	10:08	42	0.9	1	1.4	1.6
	26	7:35	16:30	236	0.8	1	0.3	0.4
	27	9:30	15:21	141	0.9	6	2.6	2.9
	28	8:38	10:15	97	1.0	1	0.6	0.6
		10:45	14:45	240	0.4	4	1.0	2.5
April	1	8:17	9:55	98	0.6	4	2.5	4.2
		10:16	13:47	211	1.0	8	2.3	2.3
	2	7:50	17:05	271	0.7	12	2.7	3.9
	3	9:17	12:50	197	0.7	13	4.0	5.7
	4	15:10	17:10	120	0.9	5	2.5	2.8
	5	8:37	13:32	263	0.8	15	3.4	4.2
	8	11:00	12:30	90	0.5	3	2.0	4.0
		14:45	15:50	65	0.5	4	3.7	7.4
	12	16:25	17:00	35	0.4	1	1.7	4.2
	13	8:35	15:07	392	0.8	7	1.1	1.4
	14	11:00	12:00	60	0.4	1	1.0	2.5
		15:42	16:17	35	0.4	1	1.7	4.2
	15	9:36	13:15	219	0.5	7	2.1	4.2
	16	10:45	12:10	85	0.4	1	0.7	1.8
		14:35	16:45	130	0.9	10	4.6	5.1
	17	10:30	11:15	45	0.5	2	2.7	5.4
		15:40	16:40	60	0.8	3	3.0	3.8
	18	10:40	14:55	200	0.3	5	1.5	5.0

R. A. MCINTOSH, AUCKLAND, N. Z.
(N. Z. Civil Time)

		Began	Ended	Min.	Factor	Meteors	Rate	Cor. Rate
1929 March	9	2:12	3:30	78	1.0	12	9.2	9.2
	11	2:15	3:35	80	1.0	13	4.3	4.3
	14	2:35	4:35	120	1.0	15	7.5	7.5
	20	3:08	4:45	97	1.0	17	10.0	10.0

MILLARD BENNETT, FORT WAYNE, IND.
(Central Standard Time)

		Began	Ended	Min.	Factor	Meteors	Rate	Cor. Rate
1929 March	12	10:30	11:15	105	0.7	7	4.0	5.7
	14	10:30	11:40	70	0.7	2	1.7	2.4
	17	9:40	10:45	65	0.7	5	4.6	6.6

MARTIN DARTAYET, NATIONAL OBSERVATORY, LA PLATA, ARGENTINA.
(Greenwich Civil Time)

		Began	Ended	Min.	Factor	Meteors	Rate	Cor. Rate
1928 Nov.	15	2:15	4:15	120		4	2	
Dec.	3	3:07	4:35	88		2		
Casuals						2		

VINCENT ANYZESKI, NEW HAVEN, CONN.
(Eastern Standard Time)

		Began	Ended	Min.	Factor	Meteors	Rate	Cor. Rate
1929 May	9	8:30	11:00	150	1.0	25	10.0	10.0
	10	8:20	11:00	160	0.9	21	7.9	8.8
	11	9:00	11:30	150	0.9	24	9.6	10.7

TABLE II.

RADIANTS BY R. A. McINTOSH.

No.	Date	α	δ	Meteors	Acc.	Notes
107	1929 March 9.64	241°5	—43°0	7	Fair	
108	13.67	231.3	—42.0	5	Good	
109	13.67	272.0	—40.0	3	Fair	
110	20.68	272.0	—21.5	4	Good	
111	20.68	272.0	—40.5	7	Good	
—	9.64	215.	—23.	4	Poor	These 4 radiants are considered uncertain by McIntosh.
—	9.64	235.	—19.	4	Poor	
—	9.64	272.	—40.	4	Poor	
—	13.67	210.	—24.	2	Poor	

RADIANTS BY B. C. DARLING.

No.	Date	α	δ	Meteors	Acc.	Notes
1	1929 March 14.	184.	+36.	3+	Good	
2	April 2.±	198.	+14.	3	Poor	
3	2.	214.	+41.	2		see No. 6
4	3.	182.	+36.	3	Fair	1 on April 5 also
5	5.	231.	+29.	3	Good	2 on April 1 also
6	5.	217.	+38.	3	Good	see No. 3
7	16.±	313.	+39.	4	Good	
8	17.±	284.	+37.	5-8	Fair	Lyrids
9	18.	273.	+29.	3	Poor	

RADIANTS BY V. ANYZESKI.

No.	Date	α	δ	Meteors	Acc.	Notes
1	1929 May 9.	190.	+14.	4	Good	2 on May 10 also
2	9.	198.	— 2.	4-5	Good	
3	9.	219.	+14.	7	Good	4 on May 10 & 11 also
4	10.	221.	— 9.	4	Good	1 on May 9 also
5	10.	195.	+23.	3	Poor	
6	11.	228.	+31.	4-5	Good	
7	11.	232.5	+15.	4-5	Good	

FIREBALL OF JUNE 28, 1927.

On the evening of June 28, 1927, at 7:48 C.S.T., a very fine fireball crossed the states of Tennessee and Kentucky, in a general direction from southeast to northwest. It was reported to have exploded near Owensboro, Kentucky, and was given considerable attention by the papers. The writer was unable just then to make the usual campaign for getting data on this fireball, and most of his information came through Mr. Latimer J. Wilson of Nashville, Tennessee, who exerted himself in the matter, besides sending in his personal observation. In all, besides the newspaper accounts, eight persons filled out questionnaires, and these form the basis of our conclusions. At Nashville, Tennessee, it was observed by L. J. Wilson, Mrs. H. B. Clements, Mrs. L. H. Terry, and C. H. Parker; at Chattanooga, Tennessee, by C. C. Williford of the U. S. Weather Bureau; at Trenton, Kentucky, by J. W. Robertson; at Owensboro, Kentucky, by Mrs. Virginia Duncan and the Rev. C. C. Miller.

Twilight was still strong and no stars were visible. Hence positions could

be given only by estimated altitudes and azimuths, with the usual unavoidable disagreements. Computations of the approximate path in the atmosphere was made somewhat more certain by the use of the zenith distances given by the Nashville observers, when the object was nearest them. Undoubtedly, the path was not a straight one but strongly curved in the latter part, which further complicated matters. The data are not sufficiently accurate for a rigorous solution to be undertaken, though the azimuth of the plane of motion is quite well determined. An approximate solution leads to the following results:

Began over Long. 85° 13′, Lat. +34° 54′, Height 150 miles.
Exploded over 87 30, 37 44, 10 .
Length of path (considered as straight; it was actually curved) 268 miles.
Radiant point azimuth 330°, altitude 39°, zenith correction —3°, right ascension 240°.0, declination —11°.2, longitude 240°.2, latitude +9°.2.

Elements of parabolic orbit:

i	4°	for local sidereal time at end point, 1927 June 28, $14^h\ 22^m\ 37^s$.
Ω	96°	
π	315°	
q	0.91	

Greater reliance can be placed in the descriptions of its aspect than in the above numerical data. Over Chattanooga it appeared equal to Venus, over Nashville 5 times Venus to Moon, over Owensboro equal to full Moon. Its curved path was both drawn by some and described by others as such. The fireball exploded when north of Nashville, and ended finally in another grand explosion, low in the northwest, breaking into not less than three large pieces. No observer heard any sound whatever, despite newspaper accounts which mention a sound "like an aeroplane." Wilson described it as follows: "The object (flame) was pear-shaped, brilliant blue-white at the large end, (the preceding end), and violet, crimson, and scarlet in the stream-line tail which extended fully ½° behind. It . . . left a wake of coarse red sparks falling vertically and soon extinguished. There was no trail of smoke to mark the path across the darkening clear sky . . " He saw only the last 10° of its path. The others used the words "yellow, fire-color, white, orange, bluish-fire" to describe its color. As Wilson clearly states, it showed several colors. Its flight took 2½, 3, 4½, 6+, 7½, and 15 seconds according to various observers. It is quite obvious that some of these saw only part of the path. Also, all the times are mere estimates from memory some days or weeks after by persons not accustomed to such work. Hence the times are useless for determining the apparent velocity in our atmosphere.

A comparison of the elements derived above show resemblances to those of the Pons-Winnecke Comet, which, on the date that the fireball appeared, was very near the earth. Considering the uncertainty of the data on which the fireball's orbit is based, the writer considers it more than probable that the fireball belonged to the comet's system. Further, from the character of the final explosion, and the relatively low altitude at which it occurred, the larger fragments probably reached the ground as meteorites. They may eventually be found about 25 miles west of Owensboro, or just east of Rankin, Kentucky.

Sincere appreciation is hereby expressed to all persons who so kindly aided by filling out questionnaires, and most of all to Mr. Latimer J. Wilson for his invaluable personal aid.

Flower Observatory, Upper Darby, Pennsylvania, 1929 May 16.

Appeal for Historical Researches on the Leonids and Other Meteors.

Reports from observers indicate that the Leonid meteors have begun again in what should be their thirty-first reappearance since A.D. 902, "the year of the stars." Of these possible reappearances known records exist of only a part. The great work of Newton, Adams, and Schiaparelli, done in the sixties of the nineteenth century, depended on reports of only fifteen. These were found scattered in the annals of Europe, the Hither Orient, Africa, and China by Chladni and his successors, by Harrick, Chasles, Perrey, E. Biot, and A. Quetelet. Quetelet summarized the history of meteor showers in successive catalogues, the last of which appeared in 1861. The Leonid records collected by Newton in the *American Journal of Science* for 1864 have hardly been augmented in the sixty-four years since.

It is obvious that many sources of information have not been searched. Such are, the records of Indian and perhaps Egyptian literature, the *Relations* of the Jesuit missionaries to Canada, other reports, civil and military, from the French possessions to the home government, and reports of all sorts from Spanish America, Brazil, and the Philippines to the Church authorities, and to the governments in Madrid and Lisbon. Probably also the logs of shipping and the records of merchants contain references to meteors, and, among them, to the Leonids. Perhaps the investigators of Mayan astronomy may be able to add to them. It is hard to believe that E. Biot's search of Chinese literature, ended eighty years ago, exhausted the vast reservoir, and the annals of Japan and Korea are equally unfinished.

It is therefore suggested that persons who have access to such records, or who are conversant with their contents, should either publish in full detail, and as soon as convenient, catalogues of ancient meteor observations, or should send copies in manuscript to persons or institutions able to make good use of them.

An understanding of the calendars involved is the only astronomical knowledge necessary for such historical research.

The dates related to Leonid showers are likely to be found about the beginning of each century, and about one-third and two-thirds through each century. For several hundred years they have come in early November, while previously they were in October, and still earlier, in September. Research may discover references to these and other well-known showers in works not now known to contain such; and others of earlier date may be found, of the Renaissance and the Middle Ages.

An appeal essentially as above has been circulated privately, and has already elicited information derived from a search of Russian chronicles, by D. Sviatsky, of Leningrad. And also a list has been received, of probable Leonid dates, unearthed by K. Hirayama, of Tokyo Observatory, from Japanese and Korean records. Of the dates in that list, eight are entirely new to occidental astronomy, and fill many gaps in the record.

It is evident that the compliance of scholars with the request for historical research in the field of shooting stars, meteors, and fireballs would be a distinct service to science.

The Harvard Observatory Library begs to be favored with reprints, etc., of publications bearing on this topic.

WILLARD J. FISHER.

Harvard College Observatory, Cambridge, Massachusetts.

COMET NOTES.

By G. VAN BIESBROECK.

These notes will be unusually short on account of the absence of any comets known to be in reach of visual observations. In the evening sky COMET 1929 *a* (SCHWASSMANN-WACHMANN) may perhaps be recorded yet by the more powerful photographic method at the end of May, but it will soon be lost after that in the vicinity of the sun. It is very doubtful if its trace will be picked up again next winter after the conjunction with the sun, because the brightness has fallen off rapidly. From measures on a plate exposed here on April 29 the writer finds for the correction of the ephemeris given on p. 245:

$$\Delta\alpha = -26^s \text{ and } \Delta\delta = +0'.4.$$

On that date the comet appears very diffuse and the total brightness is of the order of a 14^M star. Unfavorable weather conditions have prevented further observations up to this date.

It is hardly necessary to give a continuation of the ephemeris for this comet in June. But it may be of interest to give here a pre-discovery ephemeris sent by L. E. Cunningham. He computed this from Crommelin's orbit (see p. 175) in the hope of finding more images of the comet on Harvard plates but he did not locate any trace of it on a dozen plates covering the region and showing stars to the 12th and some to the 15th magnitude.

EPHEMERIS FOR COMET 1929 *a* IN 1928.

1928 0^h U.T.	α (1929.0) h m s	δ ° ′
June 10	3 2 14	+14 11.3
26	3 27 31	15 46.1
July 12	3 53 0	17 5.8
28	4 18 35	18 9.5
Aug. 13	4 43 40	18 55.3
29	5 7 44	19 23.3
Sept. 14	5 30 1	19 34.6
30	5 50 16	19 32.0
Oct. 16	6 4 57	19 20.6
Nov. 1	6 14 50	19 6.9
17	6 17 41	18 58.8
Dec. 3	6 12 52	19 3.1
19	6 1 42	+19 22.3

There is a chance that images of the comet might yet be found on some of the numerous plates accumulated these days in various observatories.

No further observations on COMET 1927 *d* (STEARNS) have been published. The conditions of visibility will improve a little as the object moves toward opposition on August 1. It stays at high northern declinations and the brightness decreases very little as will be seen from the following ephemeris which we have continued for the balance of the year from Y. C. Chang's elements.

EPHEMERIS OF COMET 1927 *d* (STEARNS).

1929 0h U.T.		α h m s	δ ° ′	Log. *r*	Log. Δ	Mag.
June	14	21 26 34	+73 42.6	0.882	0.892	15.9
	22	22 47	74 22.9			
	30	17 15	74 57.6			
July	8	10 6	75 25.2			
	16	21 1 35	75 44.7	0.893	0.897	16.0
	24	20 52 7	75 55.5			
Aug.	1	42 10	75 57.0			
	9	32 20	75 49.1			
	17	23 11	75 31.9	0.904	0.901	16.1
	25	15 12	75 6.2			
Sept.	2	8 41	74 32.8			
	10	3 51	73 52.7			
	18	20 0 46	73 7.1	0.915	0.905	16.1
	26	19 59 24	72 17.2			
Oct.	4	19 59 40	71 24.1			
	12	20 1 24	70 29.0			
	20	4 26	69 32.9	0.925	0.912	16.2
	28	8 35	68 36.7			
Nov.	5	13 44	67 41.3			
	13	19 44	66 47.5			
	21	26 26	65 56.1	0.936	0.924	16.3
	29	33 42	65 7.6			
Dec.	7	41 27	64 22.6			
	15	49 34	63 41.7			
	23	20 57 58	63 5.3	0.946	0.940	16.5
	31	21 6 35	+62 33.6			

Williams Bay, Wisconsin, May 23, 1929.

OCCULTATIONS.

Prediction of Occultations for Amherst, Mass., and Vicinity.

Professor Brown's suggestions for the observation of lunar occultations have been given in many places during the past two years but it may well be that someone who wishes to observe the phenomena has not had access to such a source. A brief outline is given here.

Since observations of reappearance include several systematic personal errors which are too difficult of elimination or standardization for all observers, it is thought best to concentrate on disappearances. Furthermore, reappearances require very accurate predictions, unless the prospective observer is to waste much time in waiting for the phase. Hence the disappearances only are given in this series of predictions for Amherst.

Observations of the same occultation from points which are distant from each other only a few miles are practically independent, because of the rough contour of the moon's limb. For the same reason, the time of observation need not be quoted any more accurately than to the nearest second, unless the observer has had sufficient experience to be positive that a greater degree of accuracy is warranted. A method of observation by means of a good clock and a stop-watch of the ordinary start-stop-zero type (commonly used in athletic contests) may be outlined here. The stop-watch should have a total accumulated error of no more than 0.5 second for a minute or two and the clock should be able to keep its rate fairly constant over a period of several hours. The disappearance is awaited

with the stop-watch at zero; at the instant of disappearance the starting button is pressed. The watch is then carried to the clock and stopped when the second hand of the clock is exactly at some integral minute. The reading of the watch will give the time since the occultation occurred and this interval may be subtracted from the time when the watch was stopped, as shown by the clock. As soon as possible the clock should be compared with some standard source of time, such as radio signals or a nearby observatory. A double check on the clock, both before and after the observation, would be excellent.

If the observation is made under at all unusual circumstances, appropriate remarks should accompany the observation, such as "hazy," "gradual diminution of light," "instantaneous," etc. In the event that an unpredicted occultation is observed, sufficient data should be sent with the report to enable the star which was occulted to be identified; then an accurate position may be determined, if one is not already available. Observations should be sent to Professor Brown, at the Yale Observatory, in New Haven, Connecticut; every observation submitted will be reduced and utilized.

Similar predictions for an area surrounding the Lick Observatory are given in the *Publications of the Astronomical Society of the Pacific;* the *American Ephemeris and Nautical Almanac*, beginning with the year 1931, will include a similar list for the Washington area, instead of the present type of list, which may be used only in the immediate vicinity of Washington. It is desirable that the entire country be blanketed by predictions for various centers from which observations are likely to come, so anyone who wishes to help in the work of prediction will confer a favor on those who are using the observations by getting in touch with the computer of this list, from whom full details of the easy method which is used may be obtained.

TABLE OF PREDICTIONS.
(Disappearances Only)

Date 1929		Star	Mag.	G.C.T. h m	a m	b m	P °
July	4	κ Tauri	4.1	8 31	—0.1	+1.1	97
	4	67 Tauri	5.4	8 36	—0.6	+0.5	123
	23	35 Capricorni	6.0	7 45	—3.2	—2.4	120
	26	376 B. Aquarii	6.3	7 20	—1.4	—1.5	47
	27	14 Ceti	5.4	7 56	—1.7	+1.2	68
Aug.	20	161 B. Capricorni	6.4	7 36	—1.3	—0.7	76
	22	351 B. Aquarii	6.5	7 30	0.0	+2.4	3
	28	284 B. Tauri	6.0	4 37	+0.1	+1.1	97
	28	95 Tauri	6.2	7 36	—0.6	+1.8	64
	29	125 Tauri	5.1	5 10	+0.4	+1.3	75

The G.C.T. of the occultation at some other station within 300 miles of Amherst may be easily found from the coefficients a and b and the formula

$$\text{G.C.T.} = \text{Predicted G.C.T.} + a\Delta\lambda + b\Delta\phi,$$

where $\Delta\lambda$ is equal to the longitude of the place (to tenths of a degree) minus the longitude of Amherst (72.5 degrees) and $\Delta\phi$ is equal to the latitude of the place (likewise to tenths of a degree) minus the latitude of Amherst (42.4 degrees). For distances up to 300 miles the error of this formula will rarely exceed 2 minutes. The last column follows the usual convention of denoting the point of disappearance in degrees from the north point of the moon, measured for 360 degrees towards the east. This column applies only to Amherst, although it will be found in many cases that the local position angle differs very little from the tabulated value.

In this series of predictions, certain criteria are observed which determine whether or not a given occultation will be readily seen in the Amherst area. For instance, certain magnitude limitations are observed near sunrise and sunset and no occultations are listed which occur too low to be accurately observed. The minimum altitude has been set at 10 degrees. In the table given above, the occultation of 125 Tauri, on August 29, will occur slightly below this limit, but its magnitude (5.1) favored its inclusion in the list.

ROY MARSHALL.

87 Park Avenue, Delaware, Ohio.

Planetary Occultations.

Through the courtesy of Mr. T. Whitwell, the Director of the *Computing Section of the British Astronomical Association*, the following predictions of occultations of stars by planets are reproduced from the *Handbook* of the B.A.A. for 1929. They were computed by Arthur Burnet, F.R.A.S.

OCCULTATION OF B. D. +10° 321 BY VENUS, JUNE 12. This is a double star, the components being nearly equal in brightness. Burnham rates them as $8^{M}.6$ and $8^{M}.7$, which would make the combined magnitude about 8. The occultation is visible in a somewhat restricted area in North America.

Position of star (as one mass):

1929.0 R.A. $2^{h}\ 20^{m}\ 33^{s}.17$ Dec. +11° 10′ 48″.8
1929 June 12 $2^{h}\ 20^{m}\ 32^{s}.77$ +11° 10′ 50″.8

	—Immersion—		—Emersion—	
Observatory	G.C.T. h m	P.A. °	G.C.T. h m	P.A. °
Flagstaff	10 51	82	11 6	252
Lick	10 51	67	11 7	267
Mount Wilson	10 52	67	11 6	264
Tacubaya	10 51	86	11 5	247
Tucson	10 52	71	11 6	262

The phase of Venus is 0.39. For the emersion at the dark limb the two stars may probably be observed separately, the time between the reappearances being about 1½ minutes. The planet is nearly 30″ in diameter at the time.

OCCULTATION OF ω TAURI (MAG. 4.8) BY JUPITER, JULY 5. This is the brightest star occulted by a planet since 1914, and it is therefore unfortunate that the area of visibility is so restricted. The phenomenon will not in the ordinary way be visible at any established observatory. It will be well seen in Hawaii, and as it is a bright star the occultation should be visible with small instruments. There is also the possibility that the immersion may be witnessed in daylight at the large observatories in the west of North America. When the star 7 Aquarii (mag. 5.6) was occulted by Venus on 1918 March 2 the reappearance was observed at Lick two hours after sunrise. The immersion of ω Tauri, a brighter star, occurs 1½ hours after sunrise at Lick.

Position of star: 1929 July 5, R.A. $4^{h}\ 13^{m}\ 5^{s}.58$; Dec. +20° 24′ 23″.7.

	—Immersion—		—Emersion—	
Locality	G.C.T. h m	P.A. °	G.C.T. h m	P.A. °
Hawaii	14 12	93	15 16	247
Lick	14 13	93	15 18	249

The adopted star places are in each case based upon information kindly supplied by Dr. L. J. Comrie.

ROY MARSHALL.

87 Park Avenue, Delaware, Ohio.

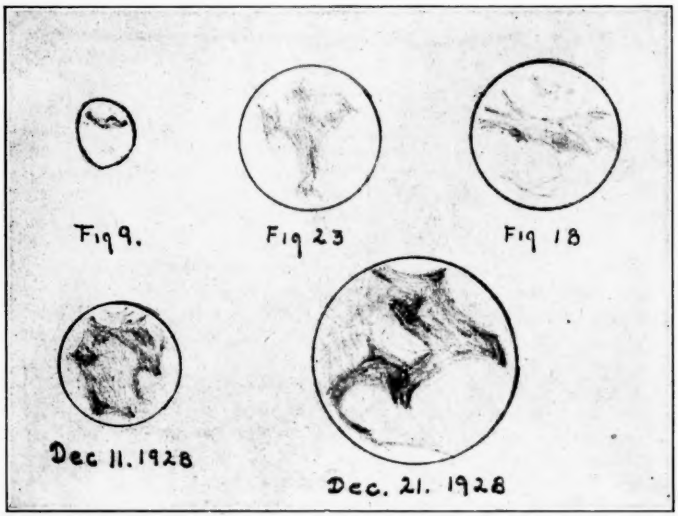
NOTES FROM AMATEURS.

Drawings of Mars by an Amateur.— I was very much interested in the article on Mars written by Mr. Henry, in the April number under "Notes from Amateurs.

The first time that I saw Mars with my own telescope plain enough to draw was during the opposition of 1926 with a 3¼-inch objective, home-made tube, mounting, and stand. When the October number in 1928 was purchased and I saw all the drawings made with 8-inch and 10-inch instruments in 1926, I immediately found my book and compared dates, finding that some showed only a few hours difference in observing time.

The drawings inclosed marked Fig. 9, 23, and 18, correspond to the same figure numbers in the October number, 1928, shown on Plates XII, XIV, and XV. Up to that time I never had the opportunity of comparing my drawings to see if there was any similarity. The powers used were 100 and 120. On a few nights no markings could be seen though the night was brilliant.

The drawing made December 11 shows the Syrtis Major that Mr. Henry speaks about in the April number, just coming around at the right side and on December 21, when the planet was about the nearest, we see it again a little to the left with bright areas at the poles, top and bottom. The Syrtis appeared blunt to me as if it was made up of a number of points.



The two drawings were made with an old 5½-inch Fitz objective of 85 inches focus, stopped down to 4 inches and using a ½-inch eyepiece giving a power of 170. The instrument has home-made tube, mounting, and stand.

HAROLD B. WEBB.

9251 173rd St., Jamaica, L. I., N. Y., May 3, 1929.

Loessal Characteristics of the Moon's Topography*.

All observers have been impressed with the fact that the craters upon the moon are not like those upon the earth. They are, many of them, enormously larger and they have, as a rule, nothing that can be construed as a gate through which molten lava has flowed from them. They appear, rather, to have been gaseous volcanoes ejecting comminuted rock, much of it in a very fine state of subdivision, as where the volcanic rays appear as white dust streaks radiating from greater and lesser craters. These craters were, apparently, the last to erupt in sufficient violence to lay their dusts widely over the lunar surface. They seem to have generated dust-laden volcanic storms that have streaked the moon as we see it, leaving weather marks—if these be weather marks—infinitely older than anything we know upon the earth.

Everything upon the lunar surface appears to be of this loessal character. Everywhere gas vents have formed with equal facility—upon the plains, upon the mountains, the isolated peaks, within the ramparts of the vaster volcanoes that bound the so-called ringed plains. Everywhere conditions appear to be the same, as though dust through countless thousands of years had settled upon everything, to be blown about again and again by eruptions, to fill old craters and to slowly level the older volcanic excavations. The volcanic vents, whatever be the force producing them, appear to be omnipresent, as though everywhere were to be found the same rock, the same resistance. What then, if this be the case, could account for the sameness of features throughout the moon's face so well as an assumption that its rock is in a state of comminution or subdivision?

To those who may object to a theory of uniformity of the moon's crustal components there is the presence of craters at the *summits of peaks* to be accounted for. The omnipresence of craters and craterlets is the strongest presumptive evidence that they are the source of the crustal materials all about them and the presumption is also, that these materials are of a loessal character, having been ejected in that state.

There is, furthermore, very little upon the moon's surface that looks like lava flows. The natural inference drawn by flyers, who have been accustomed to looking downward upon a landscape, has been that such features as the ruined rings appear to be craters buried in dust and that it is dust that makes the level floor of the larger crateral rings,—the numerous craterlets in the level floors being the source of the dusty or pulverized rock. Figure 1 shows a photograph of a highway cut in the loess near Malvern, Iowa. Well shafts have stood for years in this material without retaining walls. This excavation is seven years old. As a telescopic object only, its nature would never be guessed.

There are forms of greater craters that exhibit a gradation from typical crater to ringed plain. This gradation extends from Clavius (a typical greater crater) to Bailey (an uncompleted ringed plain whose floor has never been finally leveled up by the lesser volcanic vents) to Grimaldi and Plato, both typical ringed plains.

The rills at the bases of some volcanic ramparts have been interpreted as lava flows. In the light of all other characteristics of the moon's face it seems at least as reasonable to assume that these formations are blown-out materials arranged by the rush of gases down the outer walls of the ramparts into these rill-

*This brief statement of a new theory of the surface features of the moon is submitted for criticism by those who have made a study of our satellite.

like appearances.

Terracing within the craters is not like that of terrestrial volcanoes. They are not level like those left by molten rock but are irregular, like caving dirt, and the outer sides of the ramparts are terraced, part of the way down, similarly to the inside.

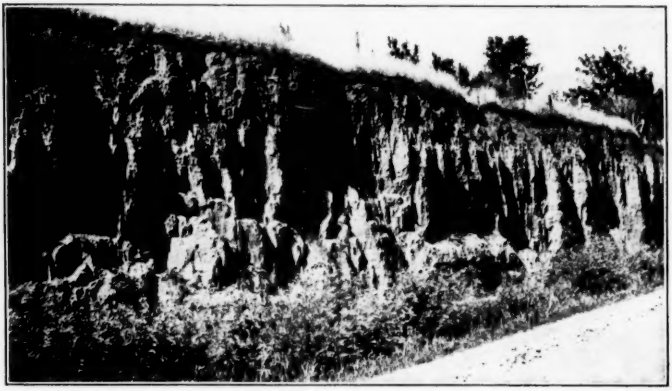


FIGURE 1.

There is very little in the lunar topography indicating that the volcanoes were other than of a gaseous character, such solid matter as was ejected being blown out as an incidental to the relief of gaseous pressure and that matter being shattered, like terrestrial breccia. Or that state of comminution may be primordial, as in the rings of Saturn. This loose state may be assumed, also, for those satellites that present one face to their primaries, as does the moon. Both the ring formation and synchronized rotation and revolution may be due to tidal effect upon loessal matter.

By estimating the depth of crateral funnels we have a means of estimating the thickness of the loessal layer. A crater the size of Grimaldi whose inner slopes rest at twenty-five degrees has a depth of fifty miles.

If the lunar conditions represent a phase in evolution of celestial bodies—and the regularity visible throughout the whole of nature leads the mind irresistibly to such an inference—vestiges of a period of similar activity may be found upon the earth. Here we find ring-like deposits of iron, discoid basins such as the Sudbury and Nipigon and the Lake Superior basin, upon either side of which heavy ore bodies are found, the metallic content, possibly, of old lunoid ramparts thrown up from deep within the earth's dense core. At any rate, we may be sure that the lunar characteristics have a meaning in terrestrial history. We must study our surface broadly, as we study the moon from afar, to find that meaning in our rocks.

SUMMARY.

1. A theory that the lunar cortex is loessal and that the lunar volcanoes were accompanied with gaseous emission only (that is, without molten rock) accounts for most of the peculiar features of the lunar topography—the volcanic rays, the maria, and the ringed plains.

2. The earliest volcanic activities upon the earth may have been of the lunar type.

3. Such an hypothesis offers plausible explanation of such geologic enigmas as the oceanic depressions, the Superior basin, the Canadian shield and the presence of large quantities of heavy metals in the earth's crustal rocks.

B. F. GILLMOR.

Red Oak, Iowa.

GENERAL NOTES.

Dr. A. A. Michelson, of the University of Chicago, left on May 8 for Pasadena, California, where he will continue his measurements of the velocity of light, using a vacuum chamber a mile in length. (*Science,* May 10.)

Mr. C. A. Robert Lundin for many years with Alvan Clark & Sons, telescope makers, has severed his connections with that firm. Mr. Lundin will continue the making of high grade astronomical telescopes.

The Buffalo Museum of Science has decided to construct a 16-foot dome to house an 8-inch refracting telescope on the roof of its building in Buffalo. The structural and mechanical work will be done by Sellew & Towner Architects, Middletown, Connecticut. The optical parts will be supplied by Mr. C. A. Lundin, Watertown, Massachusetts.

The American Association of Variable Star Observers held its spring meeting in Washington, D. C., on May 17-18. An interesting program of events was planned. Dr. W. H. Steavenson, former president of the British Astronomical Association, was present as a guest of the president, Mr. D. B. Pickering.

Asteroid Designation.—In *Astronomische Nachrichten,* No. 5623, nineteen new asteroids are assigned permanent numbers. This advances the number of asteroids for which definite orbits have been computed from 1073 to 1091. The work of computing the orbits is done at the Astronomisches Recheninstitut, Berlin-Dahlem.

The National Academy of Science at its annual meeting in Washington on April 22, 23, and 24 elected fourteen new members, among them Dr. Paul W. Merrill, astronomer at the Mount Wilson Observatory, Pasadena.

During this meeting the Watson medal was awarded to Dr. Willem de Sitter, director of the observatory at Leiden and professor of theoretical astronomy in the university. This medal was presented by Professor E. W. Brown and was received for Dr. de Sitter by the Dutch minister.

Professor E. A. Milne, of Oxford University, will lecture on Problems in Astrophysics during the present summer session of the University of Michigan from June 24 to August 16. The subjects covered will be—

Thermodynamic methods, Radioactive equilibrium, Theory of formation of absorption lines, Scattering, Selective radiation pressure, Chromospheric equilibrium, Ionization in stellar atmospheres, Saha's theory, Eddington theory of stellar

interiors, Significance of radiation pressure, Radiative equilibrium of rotating stars, Non-steady states, Pulsation of stars.

The privilege of attending lectures and seminars and of carrying on research in the laboratories and libraries during the summer session will be extended by the President of the University on recommendation of a chairman of a department, to doctors of philosophy or of science in this or other universities. There will be no charge except for laboratory supplies. Those desiring to avail themselves of this privilege should correspond with the President before the opening of the summer session.

The Amateur Astronomers Association, with headquarters in The American Museum of Natural History, New York City, under the direction of Dr. Clyde Fisher, president, and Miss M. Louise Rieker, secretary, is an active organization. Semi-monthly meetings are held to which astronomers of note are invited as speakers. The meeting on March 20 was addressed by Professor Henry Norris Russel on "Analyzing the Sun"; on May 1, by Professor Charles P. Olivier, on "Meteoric Astronomy"; and on May 15 by Mr. J. W. Fecher on "Engineering in Astronomy."

Recently the publication of a four-page pamphlet has been projected under the editorship of Dr. Clement S. Brainin. This is to appear ten times a year under the name "Amateur Astronomer." The first issue is dated April, 1929. This issue has the distinction of containing a contribution from Professor A. Einstein. Professor Einstein's message to the new publication follows:

> "Science must set itself not only the task of ever making progress. In the first instance, made possible by the daily work of the community at large, science should in turn bring to the community both enjoyment and edification. In this sense, I wish your undertaking every success.
>
> A. EINSTEIN."

POPULAR ASTRONOMY extends to "Amateur Astronomer" and to its editor and promoters most cordial greetings and hearty good wishes.

Amateur Astronomers in Buenos Aires.—An organization of amateur astronomers has recently been formed in Buenos Aires under very favorable circumstances. At the first meeting there were some two hundred persons present to hear a lecture on the moon. This organization has begun the publication of a monthly magazine entitled "Revista Astronomica."

Total Solar Eclipse of May 9.— Unfortunately we have not received any direct information from any of the eclipse parties, but the brief notices which have come to us indirectly are given here, for the benefit of those who may not have seen even the sketchy items in the press.

The first is contained in *Harvard College Observatory Announcement Card* 87, as follows:

> TOTAL SOLAR ECLIPSE.—Two cablegrams have been received today from Professor Stetson at Alor Star, in Kedah, concerning the total solar eclipse. The first, dated May 9, 5:10 A.M., announces "Good Prospects." The second, sent at 8:10 A.M., gives the following report of observation of the eclipse:
>
> HIGH CIRRUS OTHERWISE SUCCESSFUL CORONA ILLUMINATION FIFTEEN HUNDREDTHS FOOT CANDLES PRELIMINARY.
>
> HARLOW SHAPLEY.
>
> May 9, 1929.

The second is taken from the *Philadelphia Inquirer* for May 11.

Swarthmore College may be congratulated on the success of the astronomical expedition to the Orient for a view of the solar eclipse. Of attempts at several places to take photographs of the phenomenon, the Sproul Observatory enterprise and the group at Cebu in the Philippines were among the few upon whom the skies smiled. Elsewhere untimely clouds brought disappointment to months of anticipation.

In Sumatra, where the Swarthmore scientists set up their instruments, the heavens had been obscured for two weeks prior to the event; they cleared auspiciously half an hour before the moment of totality and then resumed their misty veils after the obscuration had passed. The visitors certainly played in luck as compared with their colleagues. When they gamble thousands of dollars and years of preparation against one of nature's moods lasting five minutes, and then win, the victory may be only a coincidence and the favor of fickle Fortune may have nothing to do with it.

But the layman can hardly be blamed for sharing the superstition of savages that eclipses have an uncanny faculty of rewarding certain mortals and bringing ill omen to others.

BOOK REVIEWS.

Lick Observatory Bulletin, No. 397, by W. W. Campbell and R. J. Trumpler.

This paper, issued on March 27, 1928, gives the results derived by Professor R. J. Trumpler from certain photographs taken at the total solar eclipse of September 21, 1922, with twin cameras of five (5) feet focal length. This paper has been cited as giving final and definite proof of the existence of the Einstein light deflection of 1".75; and for this reason the paper is of importance. A careful reading of the paper, however, shows that this conclusion is not warranted; that, on the contrary, the measurements and results furnish a very strong argument against the reality of any relativity deflection of light.

The first important fact, in regard to this paper, is that it is the work of, and represents the conclusions of Professor Trumpler only. In a foot-note on the title page, Professor W. W. Campbell explicitly states that he had nothing whatsoever to do with the measurement of the plates, with the computations based upon those measurements, with the discussion of the results, or with the preparation of the manuscript. This disclaimer places full responsibility upon Professor Trumpler.

A second, and far more important, fact is that this paper disregards the heretofore generally accepted practice in all astronomical investigations. It has been customary to begin all investigations by giving the actual observations on which the whole discussion rests. In Newcomb's classic memoir on the motion of the perihelion of Mercury, for example, full particulars were given in regard to every available observation. Each observation was checked against original documents. Every correction was given, and no observation was rejected, or given small weight without full explanation of the reasons for so doing. Every process in the calculation was outlined; formulas given and intermediate results printed. Thus anyone, familiar with astronomical procedure, can check every process from the original, actual, physical measures made by the many astronomers from 1631 to 1881.

But Professor Trumpler casts all such precedents into the discard. Nowhere in the paper can one find the actual physical measurements upon which the in-

vestigation rests. Not a single actual measure is given; not a single actual stellar displacement is printed. The so-called "Observed Displacements" (Tables 4 and 6) are the results of elaborate calculations depending upon least squares solutions, and involving many assumptions and adjustments of scale value, of plate constants, of refractions and temperature corrections. In Trumpler's description of the method adopted for finding the scale value used in these reductions, one finds:

> "The scale of the eclipse field photographs is necessarily linked together with the light deflections; the two cannot be separated unless some assumption is made concerning the law according to which the light deflections are related to the star's angular distance from the Sun's center."
> —page 137.

The scale and the so-called "observed displacements" were thus obtained by methods which automatically give the stars an apparent, but fictitious outward displacement. No data are given by which the web may be untangled. It is impossible, from the meagre facts printed, to reverse Trumpler's processes, and to find, from the tabulated displacements, the actual observed, or measured displacement of a single star.

Not one reader in a hundred will do more than glance over the many pages of tables and of intricate looking formulas. One and all will turn to the Summary, and will base their conclusions as to the results of the eclipse expedition, and as to the validity of the Einstein theory, upon the statements therein found. But, unfortunately, this summary does not represent the results of the investigation. With the exception of the purely formal points as to how the photographs were made, the number of plates, etc., the statements in this Summary are not in accord with the facts, and give an erroneous impression as to the methods and results of the investigation. Some of the more important of these misleading statements are examined in the following paragraphs. At the head of each paragraph is the direct quotation from the Summary; and this is followed by facts and quotations from the body of the paper itself.

> 5. "Combining the measures of the two instruments, the relative displacements of stars between 0°.5 and 10° from the Sun's center are established with a high degree of accuracy (Table 11) independently of any theoretical assumptions."

This appears to be directly contrary to many statements made in the course of the investigation. The reductions, as made, depend upon many assumptions, and notably upon the primary assumption from which the scale was determined: the assumption concerning the law according to which light deflections are related to the star's angular distance from the Sun's center.

A "check field" of stars many degrees away from the sun was photographed at night upon the eclipse plate. These stars are absolutely free from any possible Einstein effect; and from these stars Professor Trumpler found a "scale value" for the plate in accordance with ordinary astronomical usage. If this independently determined "check scale" be used for reducing the eclipse stars, then the supposed light deflections would be absolutely different from and incompatible with the Einstein prediction (page 145). Taking only stars between 2° and 3° from the sun and reducing them by the "check scale," the so-called Einstein effect would be reduced from the supposed 1".75 to 0".48 for the plates taken with the 5-foot cameras, and to 0".94 for the 15-foot cameras (page 145).

Professor Trumpler shows that these two scales might be brought together by the assumption that changes in temperature caused various expansions in different portions of the instrument. He shows that an unknown, unmeasured

difference of only 2°.5 C is sufficient to change the calculated effect from 0".48 to 1".75 in the case of the 5-foot cameras; but that a similar unmeasured difference of 7° C would be necessary in the case of the 15-foot cameras. He states, (page 145)

> "In any case there can be no question that the effect is instrumental."

But, if an unknown, unmeasured difference of temperature of only 2°.5 C can be called upon to reconcile "incompatible" results amounting to two-thirds (⅔rds) of the entire supposed Einstein effect, why cannot similar unknown, undetermined temperature differences explain and account for all of the illusive, discordant stellar displacements of the eclipse field?

> 6. "Within the limits set by the unavoidable errors of observation the star displacements are directed radially away from the Sun's center."

On the contrary, the star displacements, as shown by the various tables and diagrams, are in all sorts of directions; outward, inward, and tangential. And it must be remembered that these so-called "observed" displacements are not the actual displacements of the stars: they are relative displacements derived from assumptions that they are radial and that they follow a definite law of decrease with the "angular distance from the Sun's center" (page 137). The "star displacements" are nowhere given in the paper.

The tangential, or transverse components of the tabulated "relative" displacements are fully as large as the radial. And the determination of these transverse components was more accurate than the determination of the radial components: the probable error of the determination was less. Such probable errors are given (page 138) as:

Tangential component	±0".31
Radial component	±0".34

In the reductions the radial components are assumed to be real, while the tangential components (which show a smaller probable error) are assumed to be errors of observation. The basic method of the entire investigation is to assume that the light deflections "operate only in the radial direction," that they follow the Einstein law of decrease with distance, and to treat every departure from these assumptions as "errors of observation."

> 7. "Einstein's law that the light deflections are inversely proportional to the angular distance from the Sun's center represents the observations best."

The investigation furnishes no warrant whatsoever for this statement. As far as can be ascertained from the paper, no other law was tested. No attempt was made to determine the true character of the deflections; no attempt was made to find, from the measures, the law, if any, of distribution of the deflections in size and in direction. The entire paper assumes the Einstein law, and the reductions merely find the departures of the "relative" deflections from that law, and assumes that all such departures are "errors of observation."

And these "relative" deflections were found from a scale value "necessarily linked together with the light deflections" (page 137); they depend upon "some assumption" as to the way in which they are "related to the star's angular distance from the Sun's center." The Einstein law of decreasing size for the deflections was thus apparently written into the methods of determining the so-called "observed deflections," and then these very deflections, so determined, were compared with the very assumption from which they were derived.

9. "Abnormal refractions in the Earth's atmosphere caused by the cooling effects of the Moon's shadow could not have affected these measures appreciably."

Quite the contrary. The investigation shows that the cooling effects of the Moon's shadow not only could, but did affect the measures. But such effects are dismissed by Trumpler as being "accidental" (page 157). Professor Trumpler shows clearly that if the "observed displacements" be due to terrestrial causes (abnormal refractions and instrumental changes), then the

> "exposures during the first part of totality should give different results from those taken at the middle or towards the end of totality."

This is exactly what has always been found. It is shown by the results of the British astronomers at the 1919 eclipse; it is shown by the photographs taken by Campbell with the 15-foot cameras at the 1922 eclipse; it is shown, according to Trumpler, himself, by the photographs taken with the 5-foot cameras. In a discussion of the results of the British astronomers (*Gravitation versus Relativity*: 1922, page 214) it was shown that the average size of the deflection changed 17% as totality progressed, and that this change was progressive. This change was then cited as evidence of some terrestrial cause for a portion, at least, of the measured deflections. A similar, but very much smaller variation of the deflection with the progress of the eclipse is shown by the results of the 15-foot cameras as given by Campbell and Trumpler in *Lick Observatory Bulletin* No. 346. And in the present investigation, Trumpler states on page 157 that

> "the two first plates of the 5-foot camera give a large, the last two a small value for the light deflection."

Notwithstanding the fact that the 15-foot cameras show the same effect, although in a much smaller degree, Trumpler dismisses the entire matter with the simple phrase that the effect "must be accidental."

Further, Professor Trumpler's theoretical discussion as to the possible effects of the passage of the Moon's shadow is based upon erroneous assumptions. He assumes, as the basis of his entire calculation, that the drop in temperature, caused by the passage of the shadow, decreases steadily with the distance above the earth's surface, and disappears entirely at 5 km, or at some 16,000 feet. Such an assumption is directly contrary to all experience, and contrary to airplane observations made during totality in 1925. The fall in temperature in the upper air is greater than near the ground. Airplanes, at an altitude of 6000 feet, flew across the shadow over New Haven in 1925. The measures (available to Professor Trumpler) show that the temperature fell over 30° F within 30 seconds of the beginning of totality; that the temperature rose again to normal within a minute of the end of totality. On the ground the drop was only about 1° C.

Thus Professor Trumpler's theoretical calculations as to the possible effects of abnormal refractions are based upon erroneous premises, and his statement:

> "no reasonable assumption about the pressure and temperature distribution of the atmosphere within the Moon's shadow will increase this amount (0".001) materially"

is erroneous. Using his own formulas and methods and taking the airplane observations for the actual distribution of pressure and temperatures, the abnormal refractions would be several hundred times the amount he gives. His own formulas, used in connection with the actual results of physical and airplane observations, would make the abnormal refractions comparable in size with the so-

called "observed displacements" of this investigation.

Thus the specific statements of the Summary are not sustained by the investigation itself. The paper shows that the deflections which "furnish a value of $1''.75 \pm 0''.09$" are not the actual deflections of the stars photographed at the eclipse. They are "relative" deflections derived from and depending upon certain assumptions. Upon other assumptions these "relative" deflections take utterly different values and become quite "incompatible" with the Einstein prediction. And further, the paper shows, clearly and conclusively, that the deflections can be fully accounted for by differential expansions in the cameras, caused by minute and unmeasured differences of temperature: shows that a material portion, at least, of the measured deflections was due to terrestrial causes.

CHAS. LANE POOR.

Reply to Professor Poor's Review of Lick Observatory Bulletin No. 397.

The observations, of which *Lick Observatory Bulletin* 397 reports the results, were made at the 1922 eclipse in order to obtain information as to whether light rays are bent when passing close to the Sun, as to the amount of such bending, and as to the rate at which it decreases for stars seen at greater angular distances from the Sun's center. The data are presented as facts of observation and stand independently of whatever theories are put forward, now or in the future, for their interpretation. Professor Poor, in the preceding review, tries to discredit the observational results themselves by the method of misrepresentation. Without wishing to enter any discussion about Einstein's Theory, the present reply is merely intended to rectify Professor Poor's misstatements concerning the published results of observation and the methods by which they were derived.

The omission of the original micrometer readings which Professor Poor criticises is quite in agreement with the prevailing custom in publications of this character. The differential measures of the eclipse photographs are similar to those used in the photographic determination of stellar parallaxes and proper motions. The observers simply followed the example of the numerous recent publications on these subjects when they printed in Table 4 the measured differences between each eclipse plate and one of the night comparison plates after they had been corrected for instrumental errors as well as for refraction and aberration. These corrections were calculated according to the usual formulae for the reduction of astronomical photographs, except that for the 5-foot camera plates terms of the third order had to be included on account of the unusually large field covered by these plates. With the specific statements in the fourth paragraph of page 137 as to the formulae and the numerical constants used, any competent astronomer can easily compute the applied corrections and reconstruct the original measures. Professor Poor's remark that "it is impossible, from the meagre facts printed, to reverse Trumpler's processes, and to find, from the tabulated displacements, the actual observed or measured displacements of a single star" can thus only reflect on his own personal inability to do so.

That the method of reduction does not, as Professor Poor claims, "automatically give the stars an apparent but fictitious outward displacement" is proved by a check star field situated more than 90° away from the Sun and photographed at night on the same plates. The measures of this check star field included in the publication and reduced by the same methods do not show any systematic star displacements.

It is true that the absolute amounts of the light deflections are necessarily

linked together with the scale value of the eclipse photographs, but the observers clearly state (p. 137) that they have not attempted to observe any absolute light deflections, that they have measured only the relative displacement of each star (notably those in the immediate vicinity of the Sun) as compared with a number of reference stars in the outer portions of the plate which are on the average 7°.3 distant from the Sun's center. These relative displacements are absolutely independent of a difference in the scale of the two photographs compared. They are derived without any assumptions as to the existence of light deflections in the same way as the parallactic shift of a star relative to some faint comparison stars is measured for the determination of its parallax.

To make the meaning of a relative displacement quite clear, let us suppose we had only observed 4 stars lying exactly in a north-south line so that

Star 1 : 7°.0 north
Star 2 : 0.7 north
Star 3 : 0.7 south
Star 4 : 7.0 south
} of plate center

(The four stars 82, 74, 71, 86 are approximately so situated.) On the night photograph taken four months before the eclipse we measure the three intervals between the four stars as they normally are, undisturbed by any light deflections, and we express them as percentage of the total interval 1 - 4:

Interval 1 - 2 45%
Interval 2 - 3 10%
Interval 3 - 4 45%

These figures are evidently independent of whatever scale we use for measuring the intervals. On the eclipse photographs we measure the intervals between these same stars but find the percentage slightly changed, (44.999%, 10.002%, 44.999%); the middle interval is increased while the two outer intervals are comparatively smaller. This cannot be due to any change in the measuring scale but must be due to an actual change in the relative positions of the stars; star 2 seems to have shifted towards star 1, star 3 toward star 4. Since the stars 1 and 4 may also have changed their position at the eclipse by amounts which we cannot ascertain, our measures do not give the total amounts of the star displacements, but only the changes in the configuration; and the changes in the above percentages are what we call the relative displacements of the stars 2 and 3 as compared with the reference stars 1 and 4.

We may also compare the star 2 (0°.7 north of plate center) with two reference stars a and b of which the former is 7° east, the latter 7° west of star 2, so that in their normal position on the night photograph the 3 stars are lying exactly in a straight line. If on the eclipse photographs we find the 3 stars no longer to be in alignment but forming a flat triangle we conclude that star 2 must have shifted its position relatively to the stars a and b, as no change in the measuring scale can change the alignment of 3 stars. The observed quantities given in Table 4 of our Bulletin represent such changes in the alignment of stars and in the proportions of their intervals but measured in rectangular coördinates. Such changes in the configuration of the star field surrounding the eclipsed Sun which we have called relative star displacement are thus evidently independent of the scale value of the plates.

When Professor Poor says: "And these relative deflections were found from a scale value necessarily linked together with the light deflections," he merely shows that he does not understand at all what relative deflections are, and all his statements concerning the influence of the scale value on the observed relative star

displacements are equally erroneous. The scale value only enters the problem if somebody should want to convert the relative displacements into absolute ones. This the observers never have attempted and it is quite unnecessary; the observed relative star displacements can be compared directly with any particular theory, as any such theory predicts the relative as well as the absolute light deflections.

The observed relative star displacements in both coördinates are fully discussed as to their direction in Fig. 1 (page 146) and for the 15 best observed stars near the Sun (mean of both instruments) in Fig. 4 (page 156). The law according to which their radial components decrease when we proceed from the stars nearest to the Sun to those in the outer portions of the plate is plotted in Fig. 2 (page 151). All these data represent only observed quantities corrected for instrumental errors and the well-known effects of aberration and refraction; they are quite independent of any assumptions as to the existence or the nature of light deflections.

Professor Poor's statement that "the tangential or transverse components of the tabulated 'relative' displacements are fully as large as the radial" is simply not true as the following figures show. Taking weighted averages of the two components irrespective of sign for all stars (observations of 5-foot cameras, Table 4), we have:

Average tangential component	0".16
Average radial component	0.22

But even this comparison or similar ones[1] do not give a fair estimate of the certainty with which the star displacements have been established. It must be remembered that a large number of the observed stars fall in the outer portions of the plate and were merely used as reference stars. According to definition they have on the average no relative displacements, and for these stars the measured displacements represent mainly errors of observation. It is only for the stars near the Sun that the observers claim to have measured appreciable relative displacements due to light deflection. Any test as to whether the observed star displacements are directed radially away from the Sun or as to whether their radial components are larger than the tangential ones should therefore be based on these nearer stars alone. The case is similar to that of an observer who wishes to find out whether the rate of his clock depends on the temperature. He will for this purpose examine the few clock rates observed at extreme temperatures and not the many observations made near average temperature. It is thus clear that the relative displacements of the 15 best observed stars within 2°.5 of the Sun's center constitute the main evidence of the investigation, and it is for this reason that they were plotted separately in Fig. 4. The weighted averages taken without sign for all 69 stars within 2°.5 of the Sun's center (final results of both instruments) give:

Average tangential component	0".11
Average radial component	0.33

These figures leave no doubt that the radial components of the stars near the Sun are not due to errors of observation alone, but include a considerable effect due to light deflection.

It is hardly necessary to discuss Professor Poor's arguments concerning the effects of abnormal terrestrial refraction in the shadow cone; he offers only per-

[1] J. Porter, *Publ. A. S. P.*, June 1929.

sonal opinions and no new calculations. Moreover, there is now direct observational evidence on this question available in the measures of the Moon's diameter made (at Professor Poor's own suggestion) by the Sproul Observatory Expedition[2] at the eclipse of 1926. These observations show no measurable refraction effect "that could be interpreted as accounting even in part for the deflection of light from stars apparently near the limb of the Sun observed at the time of total solar eclipse." To illustrate the unreliability of Professor Poor's statements, we need only cite his claim that "as far as can be ascertained from the paper no other law was tested" (except Einstein's law that the light deflections are inversely proportional to the angular distance from the Sun's center). Could Professor Poor really have overlooked the whole chapter 10 (p. 155) and the large Fig. 5 (p. 157) which are given to a comparison of the observations with Courvoisier's formula?

The whole review has so many mistakes and misstatements that it is not possible to take all of them up individually. It looks as if Professor Poor either did not read the Bulletin with any care and understanding or that he wrote the review mainly to vent his personal feelings and prejudices against anything connected with Einstein's Theory.

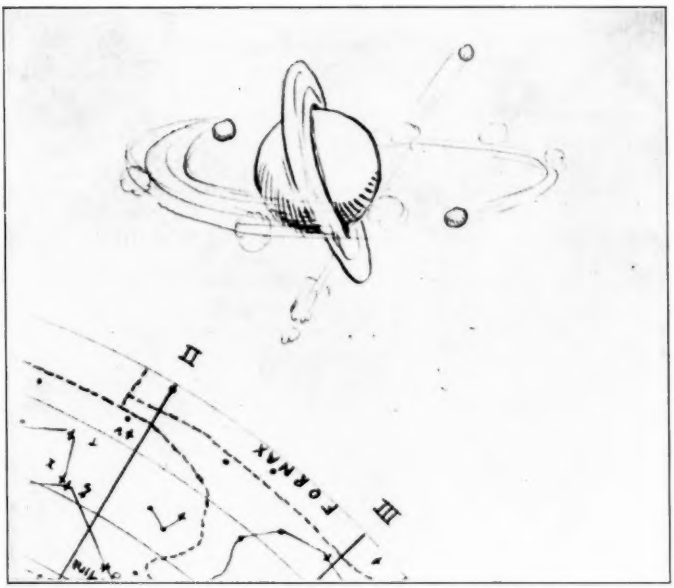
ROBERT J. TRUMPLER.

Mt. Hamilton, May 16, 1929.

[2] *Astronom. Journal*, **38**, 101, 1928.

An Astronomical Cartoon.

For some years it has been customary in the course in general astronomy at



Northwestern University to require the students to make a map of the sky from the north pole to 30° or 40° south declination. The hour circles appear as straight lines radiating from the pole; the declination circles are equally spaced. The diameter of the whole is about eighteen inches. Of course the distortion is enormous at great polar distances but something may be learned by the exercise and some problems neatly solved by means of such a map.

But this note is not concerned with the map but with the embellishments and ornaments that occasionally are found on them. The unoccupied corners naturally tempt the artist. Makers of maps both terrestrial and celestial for ages past, having accomplished a sober task, have given reign to fancy on the margins. Here we find ornamental legends, gallant ships, rolling billows of fire, or monsters from the deep. Jayhawkers are willing to maintain that the maps of Kansas found on the continental maps of the Century Atlas are placed there for ornamental as well as utilitarian purpose.

Modern college students seem to follow the age-old lure. Some of the efforts are grotesque, some highly fanciful, some give conventional figures, and occasionally there are decorations very beautiful, of pure artistry. This year has been no exception and to illustrate the point I am presenting a pair of corner ornaments on a map by Mr. Robert Mourad, Northwestern '31.

The telescope is directed across the sky to a marvellous Saturnian system. Mr. Mourad has found the astronomer in the very moment of discovery. Note how truly he has caught the spirit of exhilaration, the fine frenzy of Urania's devotee, the swift motion, the sure, keen glance, the ever ready ledger for notations. "Then felt I like some watcher of the sky." The Chinese have a proverb that a picture is worth a thousand words. Surely no verbal description could so

adequately portray this remarkable scene.

PHILIP FOX.

Dearborn Observatory, 14 April 1929.

Transactions of the International Astronomical Union, Vol. III, edited by F. J. M. Stratton, General Secretary. Cambridge (England) University Press.

This volume of nearly 350 pages contains the record of the third general assembly of the International Astronomical Union held at Leiden, July 5 to July 13, 1928. The activities of this organization are carried on through commissions, twenty-seven in number. Each of these commissions and the executive committee presented a report and certain recommendations to the general assembly. These are printed and occupy a large portion of the volume. Some of these are in English and some in French, depending apparently upon the preference of the chairman of the commission. The volume contains further the official account of what took place in the general sessions during the meeting, some of which pertained to astronomical work and some to recognition of the meetings on the part of the Government.

One finds in this volume complete information as to the organization of the union, the countries which are members of it, and in addition a considerable body of technical astronomical literature.

Volumes I and II, of this series, also may now be obtained from the Cambridge University Press.

Zodiacal Light Observations.

Unfavorable weather conditions for Zodiacal Light observations have generally prevailed during March and April. On April 29 the writer found the base of the Zodiacal Light cone at 8:15 P.M. about 25° along the horizon, thence sweeping to an altitude of 50°, passing between Orion and Auriga and continuing to Gemini. On May 5 at 8:30 P.M. he found the base of the cone extending to the northwest, the measurement being estimated at 35°. The apex of the cone was close to Mars, southeast of Pollux.

Two questions of general interest have been asked by correspondents:

1. Why does the base of the Zodiacal Light on the horizon vary in size? This effect is due to the varying angle which the ecliptic makes with the horizon at different times during the year or even at different hours on the same night. Observers note that when the ecliptic makes a high angle with the horizon the angular measurement of the base of the cone is less than when the ecliptic makes a smaller angle with the horizon.

2. Another correspondent asks if the Zodiacal Light can be seen before the disappearance of twilight. As a rule, no. Under exceptionally good conditions, however, a keen observer may glimpse the Zodiacal Light before the last lingering trace of twilight has disappeared. With the complete disappearance of twilight along the horizon the Zodiacal Light cone stands forth distinctly. It almost seems as if the twilight were merging into the Zodiacal Light.

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